ThermoQuest

# Finnigan LCQ™ DECA

Hardware Manual

Revision B

97044-97002

*Written by Fred D. Ayres and Robert W. Heather. Edited by Franklin P. Mason.*

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**Australia: ThermoQuest** • P.O. Box 239 Rydalmere• Unit 20, Metro Centre • 38 – 46 South Street • Rydalmere, N.S.W. 2116 • [61] (02) 9898-9000
**Austria: ThermoQuest GmbH** • Wehlistrasse 27b • A-1200 Wein • [43] (01) 333 50 34-0
**Belgium: ThermoQuest BVBA** • Groenenbrogerlaan 84 • B-2610 Wilrijk (Antwerpen) • [32] (03) 825 06 70
**Canada: ThermoQuest Canada** • 5716 Coopers Avenue, Unit 1 • Mississauga, Ontario • L4Z2E8 • [1] (905) 712-2258
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**Germany: ThermoQuest Analytische Systeme GmbH** • Boschring 12 • D-63329 Egelsbach • [49] (06103) 408 0
**Italy: ThermoQuest Italia S.p.A.** • Strada Rivoltana • I-20090 Rodano (Milano) • [39] (02) 95 059 1
**Japan: ThermoQuest K.K.** • Nishi-Shinjuku Toyokuni Building, 3rd Floor • 2-5-8 Hatsudai, Shibuya-ku • Tokyo 151-0061 • [81] (03) 3372-3001
**Japan: ThermoQuest K.K.** • Esaka Grand Building • 2-3-1 Esaka-cho, Suita City • Osaka 564-0063 • [81] (06) 6387-6681
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**Spain: ThermoQuest SA** • Acer 30 – 32 • Edificio Sertram – Planta 2, Modulo 3 • ES-08038 Barcelona • [34] (093) 223 0918
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# READER SURVEY
## Finnigan LCQDECA Hardware Manual
**Revision B**

*P/N 97044-97002*

Please help us improve the quality of our documentation by completing and returning this survey. Circle one number for each of the statements below.

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| The manual is well organized. | 1 | 2 | 3 | 4 | 5 |
| The manual is clearly written. | 1 | 2 | 3 | 4 | 5 |
| The manual contains all the information I need. | 1 | 2 | 3 | 4 | 5 |
| The instructions are easy to follow. | 1 | 2 | 3 | 4 | 5 |
| The instructions are complete. | 1 | 2 | 3 | 4 | 5 |
| The technical information is easy to understand. | 1 | 2 | 3 | 4 | 5 |
| The figures are helpful. | 1 | 2 | 3 | 4 | 5 |

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| EN 50082-1 | (1992) |
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| EN 61000-4-3 | (1996) |
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| EN 61000-4-4 | (1995) |
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# Contents

# Read This First

Welcome to the ThermoQuest Finnigan LCQ™DECA LC/MS$^n$ system!

This **Finnigan LCQDECA Hardware Manual** contains a description of the modes of operation and principle hardware components of your LCQDECA system. In addition, this manual provides step-by-step instructions for cleaning and maintaining your LCQDECA MS detector.

The **Finnigan LCQDECA Hardware Manual** includes the following chapters:

**Chapter 1: Functional Description** describes the principal components of the LCQDECA MS detector.

**Chapter 2: Changing ESI or APCI Probe Assemblies** contains procedures for changing ESI and APCI probes.

**Chapter 3: System Shutdown, Startup, and Reset** provides procedures for shutting down and starting up the LCQDECA system.

**Chapter 4: User Maintenance** outlines the maintenance procedures that you should perform on a regular basis to maintain optimum MS detector performance.

**Chapter 5: Service Maintenance** outlines maintenance procedures for the ion optics and electron multiplier and procedures for testing the major electronic circuits within the instrument and for replacing failed PCBs and assemblies.

**Chapter 6: Replaceable Parts** lists the replaceable parts for the MS detector and data system.

**Appendix A: Troubleshooting** provides tables for troubleshooting and diagnosing the LCQDECA.

# Changes to the Manual and Online Help

To suggest changes to this manual or the online Help, please send your comments to:

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You are encouraged to report errors or omissions in the text or index. Thank you.

# Abbreviations

The following abbreviations are used in this and other LCQDECA manuals and in the online Help.

| | |
|---|---|
| A | ampere |
| ac | alternating current |
| ADC | analog-to-digital converter |
| AP | acquisition processor |
| APCI | atmospheric pressure chemical ionization |
| API | atmospheric pressure ionization |
| ASCII | American Standard Code for Information Interchange |
| b | bit |
| B | byte (8 b) |
| baud rate | data transmission speed in events per second |
| °C | degrees Celsius |
| cfm | cubic feet per minute |
| CD | compact disc |
| CD-ROM | compact disc read-only memory |
| CI | chemical ionization |
| CIP | Carriage and Insurance Paid To |
| cm | centimeter |
| $cm^3$ | cubic centimeter |
| CPU | central processing unit (of a computer) |
| CRM | consecutive reaction monitoring |
| <Ctrl> | control key on the terminal keyboard |
| *d* | depth |
| Da | dalton |
| DAC | digital-to-analog converter |
| DAU | daughter scan mode (TSQ only) |
| dc | direct current |
| DDS | direct digital synthesizer |
| DEP™ | direct exposure probe |
| DS | data system |
| DSP | digital signal processor |
| EI | electron ionization |

| | |
|---|---|
| <Enter> | <Enter> key on the terminal keyboard |
| ESD | electrostatic discharge |
| ESI | electrospray ionization |
| eV | electron volt |
| f | femto ($10^{-15}$) |
| °F | degrees Fahrenheit |
| *.fasta* | file extension of a SEQUEST search database file |
| FOB | Free on Board |
| ft | foot |
| FTP | file transfer protocol |
| g | gram |
| G | giga ($10^{9}$) |
| GC | gas chromatograph |
| GC/MS | gas chromatograph / mass spectrometer |
| GND | electrical ground |
| GPIB | general-purpose interface bus |
| GUI | graphical user interface |
| *h* | height |
| h | hour |
| HPLC | high-performance liquid chromatograph |
| HV | high voltage |
| Hz | hertz (cycles per second) |
| ICIS™ | Interactive Chemical Information System |
| ICL™ | Instrument Control Language™ |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronics Engineers |
| in. | inch |
| I/O | input/output |
| k | kilo ($10^{3}$, 1000) |
| K | kilo ($2^{10}$, 1024) |
| kg | kilogram |
| *l* | length |
| L | liter |
| LAN | local area network |

| | |
|---|---|
| lb | pound |
| LC | liquid chromatograph |
| LC/MS | liquid chromatograph / mass spectrometer |
| LED | light-emitting diode |
| m | meter |
| m | milli ($10^{-3}$) |
| M | mega ($10^{6}$) |
| M+ | molecular ion |
| MH+ | protonated molecular ion |
| µ | micro ($10^{-6}$) |
| min | minute |
| mL | milliliter |
| mm | millimeter |
| MS | $MS^n$ power: where n = 1 |
| MS/MS | $MS^n$ power: where n = 2 |
| $MS^n$ | $MS^n$ power: where n = 1 through 10 |
| *m/z* | mass-to-charge ratio |
| n | nano ($10^{-9}$) |
| NCBI | National Center for Biotechnology Information (USA) |
| NEU | neutral loss/gain scan mode (TSQ only) |
| Ω | ohm |
| p | pico ($10^{-12}$) |
| Pa | pascal |
| PAR | parent scan mode (TSQ only) |
| PCB | printed circuit board |
| PID | proportional / integral / differential |
| P/N | part number |
| P/P | peak-to-peak voltage |
| ppm | parts per million |
| psig | pounds per square inch, gauge |
| RAM | random access memory |
| RF | radio frequency |
| RMS | root mean square |
| ROM | read-only memory |

| | |
|---|---|
| RS232 | industry standard for serial communications |
| s | second |
| SCSI | small computer system interface |
| SIM | selected ion monitoring |
| solids probe | direct insertion probe |
| SRM | selected reaction monitoring |
| SSQ® | single stage quadrupole |
| TIC | total ion current |
| TCP/IP | transmission control protocol / Internet protocol |
| Torr | torr |
| TSQ® | triple stage quadrupole |
| u | atomic mass unit |
| URL | uniform resource locator |
| V | volt |
| V ac | volts alternating current |
| V dc | volts direct current |
| VGA | Video Graphics Array |
| *w* | width |
| WWW | World Wide Web |

**Note.** Exponents are written as superscripts. In the corresponding online Help, exponents are written with a caret (^) or with *e* notation because of design constraints in the online Help. For example:

| | |
|---|---|
| $MS^n$ (in this manual) | MS^n (in the online Help) |
| $10^5$ (in this manual) | 10^5 (in the online Help) |

# Typographical Conventions

Typographical conventions have been established for ThermoQuest LC and LC/MS Division manuals for the following:

- Data input
- Notes, Cautions, and CAUTIONS
- Topic headings

## Data Input

Throughout this manual, the following conventions indicate data input and output via the computer:

- Prompts and messages displayed on the screen are represented in this manual by capitalizing the initial letter of each word and italicizing each word.
- Input that is to be entered by keyboard or buttons that are to be clicked on by the mouse is represented in **bold face letters**. (Titles of topics, chapters, and manuals also appear in bold face letters.)
- For brevity, expressions such as "choose **File | Directories**" are used rather than "pull down the File menu and choose Directories."
- Any command enclosed in angle brackets < > represents a single keystroke. For example, "press **<F1>**" means press the key labeled *F1*.
- Any command that requires pressing two or more keys simultaneously is shown with a hyphen connecting the keys. For example, "press **<Shift>-<F1>"** means depress and hold the <Shift> key and then press the <F1> key.

## Notes, Cautions, and CAUTIONS

Notes, Cautions, and CAUTIONS are displayed in boxes such as the one below.

> **Note.** Boxes such as this are used to display Notes, Cautions, and CAUTIONS.

A ***Note*** contains information that can affect the quality of your data. In addition, notes often contain information that you may need if you are having trouble.

A ***Caution*** contains information necessary to protect your instrument from damage.

A ***CAUTION*** describes hazards to human beings. Each CAUTION is accompanied by a CAUTION symbol. Each hardware manual has a blue CAUTION sheet that lists the CAUTION symbols and their meanings.

## Topic Headings

The following headings are used to show the organization of topics within a chapter:

# Chapter 1

# Chapter Name

## 1.2 Second Level Topics

### Third Level Topics

#### Fourth Level Topics

***Fifth Level Topics***

# Reply Cards

LCQDECA manuals contain one or two reply cards. All LCQDECA manuals contain a Reader Survey card and some contain a Change of Location card. These cards are located at the front of each manual.

A message on the Reader Survey card asks the user to please fill out and return the card after he or she has had an opportunity to use the manual. The Reader Survey card has two functions. First, it allows the user to tell ThermoQuest LC and LC/MS Division what he or she likes and does not like about the manual. Second, when the user returns the card, he or she is placed on the ThermoQuest LC and LC/MS Division mailing list. Thus, the user will receive ThermoQuest's newsletter *Analytical News* and will be notified of events of interest, such as user meetings.

A message on the Change of Location card asks the user to please fill out and return the card only if he or she moves the instrument to another site within the user's company or if he or she sells the instrument. The purpose of the Change of Location card is to allow ThermoQuest LC and LC/MS Division to track the whereabouts of the instrument. Occasionally, we need to notify owners of our products about safety or other issues.

# Chapter 1
# Functional Description

The following topics are discussed in this chapter:

- API source
- Ion optics
- Mass analyzer
- Ion detection system

# 1.1 API Source

The atmospheric pressure ionization (API) source forms gas phase sample ions from sample molecules that are contained in solution. The API source also serves as the sample interface between the LC and the MS detector. You can operate the API source in either the electrospray ionization (ESI) or atmospheric pressure chemical ionization (APCI) mode.

The API source consists of two assemblies:

- API probe assembly (ESI or APCI)
- API stack

## API Probe Assembly

The API probe assembly is the portion of the API source that is external to the vacuum manifold. You can change the ionization mode of the MS detector and switch the probe assemblies without breaking the vacuum.

Two API probe assemblies are available with the LCQDECA:

- ESI probe assembly
- APCI probe assembly

### ESI Probe Assembly

The ESI probe assembly consists of the ESI flange and the ESI probe. See Figure 1-1. The ***ESI flange*** holds the ESI probe in position next to the entrance of the heated capillary, which is part of the API stack. The ESI flange also seals the atmospheric pressure region of the API source. In addition, when it is in the operating position against the spray shield, the ESI flange compresses the high-voltage safety-interlock switch. The ESI flange mounts on rails that allow movement of the flange toward and away from the vacuum manifold for easy servicing. Two ***flange retainer bolts*** hold the flange in place against the spray shield of the API stack. A ***grounded fitting holder*** secures a stainless steel grounded fitting that connects the sample transfer line to the PEEK safety sleeve and fused-silica sample tube.

The ***ESI probe*** produces charged aerosol droplets that contain sample ions. The ESI probe accommodates liquid flows of 1 µL/min to 1 mL/min without splitting.

The ESI probe includes the fused-silica sample tube, PEEK safety sleeve, ESI spray needle, ESI spray nozzle, and ESI manifold. Sample and solvent enter the ESI probe through the fused-silica sample tube. The sample tube is a section of 0.1 mm ID fused-silica capillary that extends from a Fingertight fitting and ferrule secured to the grounded fitting holder, through the sample inlet, and into the spray needle. The spray needle, to which a large negative or positive voltage is applied (typically ±4.5 to ±5 kV), sprays the sample solution into a fine mist of charged droplets. The spray nozzle directs a flow of sheath gas and auxiliary gas at the droplets.

The ESI manifold houses the spray nozzle and the spray needle and includes the sheath gas, auxiliary gas, and sheath liquid plumbing. The sheath gas plumbing and auxiliary gas plumbing deliver dry nitrogen gas to the spray nozzle. The sheath liquid plumbing delivers sheath liquid to the spray nozzle.

The ESI probe has inlets for the introduction of sample solution, sheath gas, auxiliary gas, and sheath liquid into the API source. The sheath gas is an inner coaxial nitrogen gas that sprays (nebulizes) the sample solution into a fine mist as it exits the sample tube. Typical sheath gas flow rates for ESI are 20 to 40 psi for sample flow rates of 5 to 10 µL/min and 80 units for sample flow rates of 200 to 1000 µ/min. When you tune the LCQDECA, you may need to adjust the sheath gas flow rate until the ion signal is stable.

The auxiliary gas is an outer coaxial nitrogen gas that assists the sheath gas in the nebulization and evaporation of sample solutions. The auxiliary gas also helps lower the humidity in the ion source. Typical auxiliary gas flow rates for ESI are 10 to 20 units. Auxiliary gas is usually not needed for sample flow rates below 100 µL/min. Refer to Table 1-1 for specific guidelines for LC/ESI/MS operation.

The sheath liquid is a solvent used to stabilize and enhance the ESI process for some solution chemistries (for example, high aqueous content) that do not readily form an electrospray and to provide make-up solvent in CE and CEC applications. Sheath liquid is injected by the syringe pump and exits the spray nozzle coaxially to the sample tube.

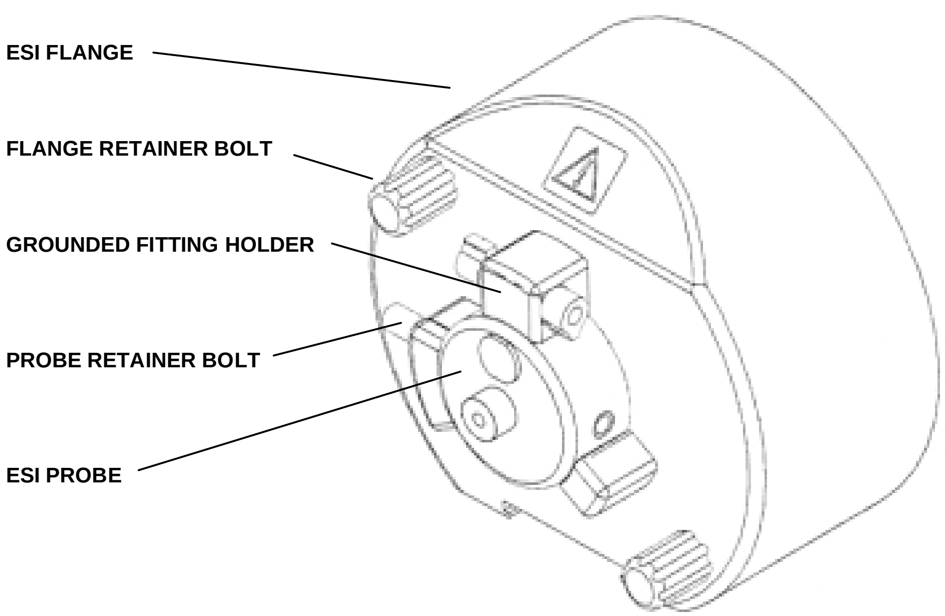



**Figure 1-1. ESI probe assembly**

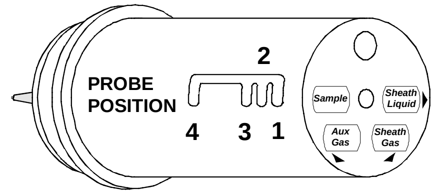



**Table 1-1. Guidelines for LC/ESI/MS Operation**

| LC Flow Rates | Suggested Column Size | Probe Position (1 to 4) | Heated Capillary Temperature | Sheath Gas | Auxiliary Gas |
|---|---|---|---|---|---|
| Infusion or LC at flow rates of ≤10 µL/min | Capillary | 2 | Typical setting: 150 to 275 °C | Required<br>Typical setting: 20 to 40 units | Not required<br>Typical setting: 0 units |
| LC at flow rates from 50 to 100 µL/min | 1 mm ID | 2 | Typical setting: 350 °C | Required<br>Typical setting: 80+ units | Not required, but might help depending on conditions |
| LC at flow rates from 200 to 500 µL/min | 2 to 3 mm ID | 3 | Typical setting: 350 °C | Required<br>Typical setting: 80+ units | Not required, but usually helps to reduce solvent background ions<br>Typical setting: 20 units |
| LC at flow rates from 0.5 (probe position 3) to 1 mL/min (probe position 4) | 4.6 mm ID | 3-4 | Typical setting: 350 °C | Required<br>Typical setting: 80 to 100 units | Required<br>Typical setting: 20 units |

**Note.** In negative ion mode, waveform 2 might be required (depending on solvents and modifiers used).
In positive ion mode with flow rates of >400 µL/min, waveform 2 might be required.
To change the Injection Waveform, use the Tune Plus window Injection Control dialog box.

## APCI Probe Assembly

The APCI probe and flange assembly is a single molding including the corona discharge needle assembly. See Figure 1-2. The ***APCI flange*** holds the APCI probe and the corona discharge needle assembly in position next to the entrance of the heated capillary. As with the ESI flange, the APCI flange seals the atmospheric pressure region (also called the spray chamber) of the API source. The APCI flange mounts on rails that allow movement of the flange toward and away from the vacuum manifold for easy servicing. Two ***flange retainer bolts*** hold the flange in place against the spray shield of the API stack. When the APCI flange is in the operating position against the spray shield, it compresses the high-voltage safety-interlock switch.

The ***APCI probe*** ionizes the sample by atmospheric pressure chemical ionization. The APCI probe accommodates liquid flows of 100 µL/min to 2 mL/min without splitting.

The APCI probe includes the APCI sample tube, nozzle, sheath gas and auxiliary gas plumbing, and vaporizer. Sample and solvent enter the APCI nozzle through the sample tube. The sample tube is a short section of 0.15 mm ID fused silica tubing that extends from the sample inlet to 1 mm past the end of the nozzle. The manifold houses the APCI nozzle and includes the sheath gas and auxiliary gas plumbing. The APCI nozzle sprays the sample solution into a fine mist. The sheath gas and auxiliary gas plumbing deliver dry nitrogen gas to the nozzle. Typical sheath gas flow rates for APCI are 60 units for sample flow rates of 100 µL/min, 80 units for sample flow rates of 1 mL/min, and 85 units for sample flow rates of 2 mL/min. Typical auxiliary gas flow rates for APCI are 10 to 20 units. The droplets in the mist then enter the vaporizer and the vaporizer flash vaporizes the droplets at temperatures up to 600 °C. Typical vaporizer temperatures are 450 to 550 °C for most flow rates. Refer to Table 1-2 for specific guidelines for LC/APCI/MS operation.

**Table 1-2. Guidelines for LC/APCI/MS Operation**

| LC Flow Rate | Heated Capillary Temperature | Vaporizer Temperature | Sheath Gas | Auxiliary Gas |
|---|---|---|---|---|
| LC at flow rates from 0.2 to 2 mL/min | Typical setting: 150 to 225 °C | Typical setting: 400 to 550 °C | Required<br>Typical setting: 50 to 100 units | Not required, but usually helps to reduce solvent background ions<br>Typical setting: 0 to 20 units |

The sample vapor is swept toward the corona discharge needle by the flow of the sheath and auxiliary gases. The corona discharge needle assembly is mounted on the APCI flange. The assembly positions the tip of the corona discharge needle near the vaporizer. A high potential (typically ±3 to ±5 kV) is applied to the corona discharge needle to produce a corona discharge current of up to 10 µA. (A typical value of the corona discharge current is 5 µA.) The corona discharge from the needle produces a reagent ion plasma primarily from the solvent vapor. The sample vapor is ionized by ion-molecule reactions with the reagent ions in the plasma. APCI requires a constant source of electrons for the ionization process. Thus, the corona discharge current is set and regulated. The potential applied to the corona discharge needle varies, as needed, to provide the required current.

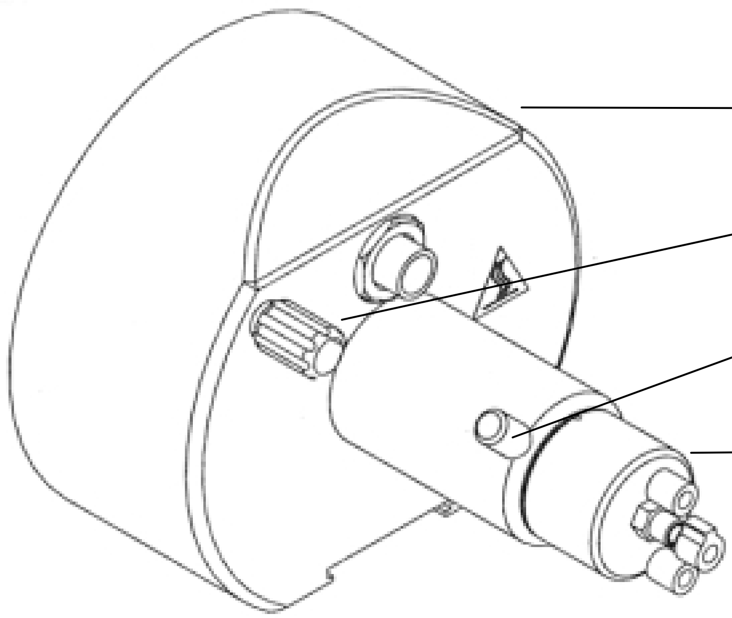



**Figure 1-2. APCI probe assembly**

## API Stack

The API stack consists of the components of the API source that are held under vacuum (except for the atmospheric pressure side of the spray shield). The API stack includes the spray shield, heated capillary, tube lens, skimmer, heated capillary mount, and tube lens and skimmer mount. The same API stack is used for both ESI and APCI ionization modes. See Figure 1-3.

The spray shield is a stainless steel, concave assembly that, in combination with the ESI or APCI flange, forms the atmospheric pressure region of the API source (also called the spray chamber). The spray shield inserts into an opening in the vacuum manifold and serves as a base for the API stack. An opening in the bottom of the spray shield serves as a drain for waste liquid. Two flange retainer bolts on the ESI or APCI flange secure the flange to the atmospheric pressure side of the spray shield.

The heated capillary assists in desolvating ions that are produced by the ESI or APCI probe. The heated capillary is an elongated, cylindrical tube made of metal that has a hole bored through the center of its long axis. A heater embedded in the capillary surrounds the hole and heats the capillary to temperatures up to 350 °C. Typical temperatures of the heated capillary are 250 (for infusion) to 350 °C (for flow rates above 50 µL/min) for ESI and 150 °C for APCI. For submicroliter flow rates it might be necessary to reduce heated capillary temperatures to 200 °C. Refer to Table 1-1 and Table 1-2 for specific guidelines for capillary temperatures in LC/ESI/MS and LC/APCI/MS operation.

The heated capillary passes through a hole in the center of the spray shield. Ions are drawn into the heated capillary in the atmospheric pressure region and are transported to the capillary-skimmer region of the vacuum manifold by a decreasing pressure gradient. Typically, a potential of 0 to ±10 V (positive for positive ions and negative for negative ions) assists in transporting ions from the heated capillary to the skimmer.

Ions exiting the heated capillary enter the tube lens. The tube lens (also called the tube gate) has a potential applied to it to focus the ions towards the opening of the skimmer. During ion collection an additional potential of between 0 and ±40 V (positive for positive ions and negative for negative ions), called the tube lens offset voltage, can be applied to the tube lens to accelerate the ions into the background gas that is present in the capillary-skimmer region. Collisions with the background gas aid in the desolvation of the ions and increases sensitivity. If the tube lens offset voltage is too high, however, collisions with the background gas can be energetic enough to cause the ions to fragment. This fragmentation, called ion source collision induced dissociation (CID), decreases sensitivity. When you tune the LCQDECA, you adjust the tube lens offset voltage to maximize sensitivity by balancing desolvation with fragmentation.

The tube lens also serves as a gate to stop the injection of ions into the mass analyzer during ion detection. A potential of -200 V is used to deflect positive ions away from the opening in the skimmer, and a potential of +200 V is used to deflect negative ions away from the opening in the skimmer.

Ions from the tube lens pass through the skimmer and enter the ion optics region. The skimmer acts as a vacuum baffle between the higher pressure capillary-skimmer region (at 1 Torr) and the lower pressure ion optics region (at $10^{-3}$ Torr) of the vacuum manifold. The skimmer is at ground potential. The bore of the heated capillary is mechanically offset with respect to the opening in the skimmer to reduce the number of neutral molecules and large charged particles that pass through the skimmer, which might create detector noise.

The heated capillary mount screws into the spray shield on the capillary-skimmer region side. The tube lens and skimmer mount attaches to the heated capillary mount. The tube lens and skimmer mount contains spring-loaded machine screws that hold the tube lens and skimmer in place. The heated capillary abuts with the tube lens and skimmer mount, thus ensuring that the exit end of the heated capillary is at the proper distance from the opening in the skimmer.

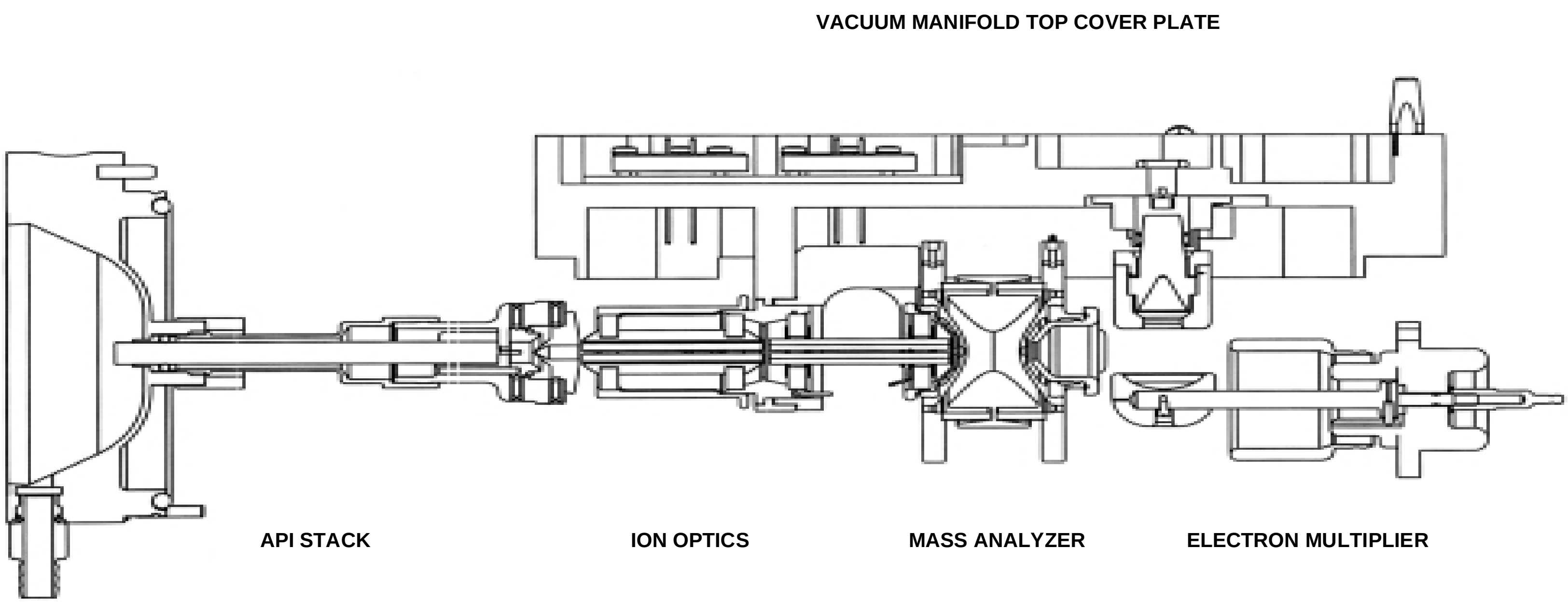



**Figure 1-3. MS detector cross sectional view**

## 1.2 Ion Optics

Ions enter the ion optics after passing through the skimmer. The ion optics transmit ions from the API source to the mass analyzer. The ion optics consist of one quadrupole, one octapole, and an interoctapole lens. See Figure 1-3.

The quadrupole is a quadrilateral array of square rods that acts as an ion transmission device. An RF voltage (2.45 MHz, 400 V peak to peak) and dc offset voltage (typically -10 to +10 V) that are applied to the rods give rise to an electric field that guides the ions along the axis of the quadrupole. During ion transmission, the offset voltage is negative for positive ions and positive for negative ions.

The octapole is an octagonal array of cylindrical rods that acts as an ion transmission device. An RF voltage (2.45 MHz, 400 V peak to peak) and dc offset voltage (typically -10 to +10 V) that are applied to the rods give rise to an electric field that guides the ions along the axis of the octapole. During ion transmission, the offset voltage is negative for positive ions and positive for negative ions. The quadrupole/octapole RF voltage is turned off during mass analysis.

The quadrupole and octapole are separated by the interoctapole lens. The interoctapole lens assists in the focusing and gating of ions. The interoctapole lens also serves as a baffle between the quadrupole region and the analyzer region of the vacuum manifold. The LCQDECA tune procedure optimizes the potentials that are applied to the quadrupole, octapole, and interoctapole lens to maximize the ion current to the mass analyzer. During ion transmission, a potential of typically between -20 and +20 V is applied to the interoctapole lens. The potential is negative for positive ions and positive for negative ions. During mass analysis, the potential is +130 V for positive ions and -130 V for negative ions.

# 1.3 Mass Analyzer

The mass analyzer is the site of mass analysis (that is, ion storage, ion isolation, collision induced dissociation, and ion ejection). The mass analyzer is mounted on the analyzer mount opposite the octapole.

The mass analyzer includes three stainless steel electrodes: the entrance endcap electrode, the exit endcap electrode, and the ring electrode. The inner surfaces of electrodes are hyperbolic. Together, they form a cavity in which the mass analysis occurs. See Figure 1-3.

The entrance endcap electrode is the electrode that is closest to the ion optics, and the exit endcap electrode is the electrode that is closest to the ion detection system. Both endcap electrodes have a small hole in their centers to permit the passage of ions into and out of the mass analyzer cavity. The ring electrode is located between the endcap electrodes. Ions produced in the API source enter the mass analyzer cavity through the entrance endcap electrode. Ions can be ejected through either endcap electrode during mass analysis. Ions that are ejected through the exit endcap electrode are focused by the conversion dynode accelerating potential through the exit lens (at ground potential) towards the ion detection system.

Helium damping gas enters the mass analyzer cavity through a nipple on the exit endcap electrode.

The entrance endcap electrode, exit endcap electrode, and ring electrode are separated by two quartz spacer rings. The spacer rings position the electrodes at the proper distance apart and also serve as electrical insulators. Two nonconducting analyzer posts pass through both endcap electrodes and screw into the analyzer mount (also nonconducting). A spring washer and analyzer nut on the end of each post apply a force to the exit endcap electrode that holds the electrodes and spacers in place.

# 1.4 Ion Detection System

The LCQDECA is equipped with a high sensitivity, off-axis ion detection system that produces a high signal-to-noise ratio and allows for voltage polarity switching between positive ion and negative ion modes of operation. The ion detection system includes a 15-kV conversion dynode and a channel electron multiplier. The ion detection system is located at the rear of the vacuum manifold behind the mass analyzer. See Figure 1-3.

The conversion dynode is a concave metal surface that is located at a right angle to the ion beam. A potential of +15 kV for negative ion detection or -15 kV for positive ion detection is applied to the conversion dynode. When an ion strikes the surface of the conversion dynode, one or more secondary particles are produced. These secondary particles can include positive ions, negative ions, electrons, and neutrals. When positive ions strike a negatively charged conversion dynode, the secondary particles of interest are negative ions and electrons. When negative ions strike a positively charged conversion dynode, the secondary particles of interest are positive ions. These secondary particles are focused by the curved surface of the conversion dynode and are accelerated by a voltage gradient into the electron multiplier. The conversion dynode shield, tube, and disk shield the vacuum manifold from the electric field produced by the conversion dynode.

The electron multiplier is mounted on the top cover plate of the vacuum manifold next to the mass analyzer. The electron multiplier includes a cathode and an anode. The cathode of the electron multiplier is a lead-oxide, funnel-like resistor. A potential of up to -2.5 kV is applied to the cathode by a high voltage ring. The exit end of the cathode (at the anode) is near ground potential. The cathode is held in place by the high voltage ring, two support plates, the electron multiplier support, and the electron multiplier shield. A spring washer applies a force to the cathode to hold it in contact with the electron multiplier shield. The electron multiplier support is attached to the top cover plate of the vacuum manifold by two screws.

The anode of the electron multiplier is a small cup located at the exit end of the cathode. The anode collects the electrons produced by the cathode. The anode screws into the anode feedthrough in the top cover plate.

Secondary particles from the conversion dynode strike the inner walls of the electron multiplier cathode with sufficient energy to eject electrons. The ejected electrons are accelerated farther into the cathode, drawn by the increasingly positive potential gradient. Due to the funnel shape of the cathode, the ejected electrons do not travel far before they again strike the inner surface of the cathode, thereby causing the emission of more electrons. Thus, a cascade of electrons is created that finally results in a measurable current at the end of the cathode where the electrons are collected by the anode. The current collected by the anode is proportional to the number of secondary particles striking the cathode. Typically, the electron multiplier is set to a gain of about $3 \times 10^5$ (i.e., for each ion or electron that enters, $3 \times 10^5$ electrons exit). The current that leaves the electron multiplier via the anode is converted to a voltage by the electrometer circuit and is recorded by the data system.

The ion detection system of the LCQDECA increases signal and decreases noise. The high voltage applied to the conversion dynode results in a high conversion efficiency and increased signal. That is, for each ion striking the conversion dynode, many secondary particles are produced. The increase in conversion efficiency is more pronounced for more massive ions than for less massive ions.

Because of the off-axis orientation of the ion detection system relative to the mass analyzer, neutral molecules from the mass analyzer tend not to strike the conversion dynode or electron multiplier. As a result, the noise from neutral molecules is reduced.

# Chapter 2

# Changing ESI or APCI Probe Assemblies

You need to change the API probe assembly (ESI or APCI) of the API source when you switch between ESI and APCI ionization modes. The ESI probe assembly consists of the ESI flange and probe. The APCI probe assembly consists of the APCI flange, probe, and corona discharge needle.

> **Note.** You do not need to shut down or vent the system to change the API probe assembly.

The following topics are discussed in this chapter:

- Installing the ESI probe assembly
- Removing the ESI probe assembly
- Installing the APCI probe assembly
- Removing the APCI probe assembly

## 2.1 Installing the ESI Probe Assembly

To install the ESI probe assembly, remove the APCI probe assembly using the procedure described in the topic **Removing the APCI Probe Assembly**, then proceed as follows:

1. Remove the ESI probe assembly from its storage container.
2. If your ESI probe assembly is not already connected with a PEEK safety sleeve and fused-silica sample tube, you need to follow the procedure for installing a sample tube and PEEK safety sleeve that is outlined in the topic **Connecting the PEEK Safety Sleeve and Fused-Silica Sample Tube to the ESI Probe** in the **Finnigan LCQDECA Getting Connected** manual.

> **Note.** Ensure that the ESI probe is secured to the ESI flange.

3. Slide the ESI probe assembly onto the probe slide adapter. Secure the ESI probe assembly to the slide adapter with the knurled fastener that is located on the underside of the slide adapter.
4. Push the ESI probe assembly against the spray shield.
5. Secure the ESI flange to the spray shield with the two flange retainer bolts.
6. Connect the sheath gas line and (blue) fitting to the inlet labeled *Sheath Gas* on the ESI probe.
7. Connect the auxiliary gas line and (green) fitting to the inlet labeled *Aux Gas* on the ESI probe.
8. Connect the sample transfer line to the grounded fitting.
9. If you are using sheath liquid, connect the sheath liquid line and fitting to the inlet labeled *Sheath Liquid* on the ESI probe. If you are not using sheath liquid, ensure that the (white) 1/4-28 Tefzel® plug (P/N 00101-18075) is screwed in the sheath liquid inlet on the ESI probe. The Tefzel plug should be fingertight. Do not overtighten the plug.
10. Connect the high voltage power cable to the connector labeled *HV* on the ESI probe. Turn the locking-ring on the cable clockwise to secure the cable.

## 2.2 Removing the ESI Probe Assembly

To remove the ESI probe assembly, proceed as follows:

1. Stop the flow of sample solution (from the LC or syringe pump) into the ESI probe.
2. If necessary, stop the flow of sheath liquid into the ESI source.
3. Disconnect the high voltage cable from the connector labeled *HV* on the ESI probe. To disconnect the cable, turn the locking ring on the cable counterclockwise until you can pull the cable free.
4. Disconnect the sample transfer line from the grounded fitting on the ESI flange. (The sample transfer line is the line that comes from the LC, divert/injector valve, or syringe pump. It is not the fused silica capillary that enters the ESI probe.)
5. Disconnect the sheath gas line and fitting from the inlet labeled *Sheath Gas* on the ESI probe.
6. Disconnect the auxiliary gas line and fitting from the inlet labeled *Aux Gas* on the ESI probe.
7. If the sheath liquid line is attached to the ESI probe, disconnect the sheath liquid line and fitting from the inlet labeled *Sheath Liquid* on the ESI probe.
8. Loosen the two flange retainer bolts that secure the ESI probe assembly to the spray shield.
9. Pull back the ESI probe assembly from the spray shield.
10. With one hand holding the ESI flange, loosen the knurled fastener that secures the ESI flange to the probe slide adapter.
11. Slide the ESI probe assembly off the probe slide adapter. Store the ESI probe assembly in its foam storage container.

## 2.3 Installing the APCI Probe Assembly

To install the APCI probe assembly, remove the ESI probe assembly using the procedure in the topic **Removing the ESI Probe Assembly**, then proceed as follows:

1. Remove the APCI probe assembly and corona discharge needle from the storage container.
2. Insert the corona discharge needle into its socket in the corona discharge needle assembly.
3. If your APCI probe assembly does not already contain a sample tube (fused-silica capillary), you need to follow the procedure for installing a sample tube that is outlined in the topic **Maintaining the APCI Probe** in the **User Maintenance** chapter of this manual. Ensure that the probe retainer bolt is tight and the APCI probe is secured to the APCI flange.

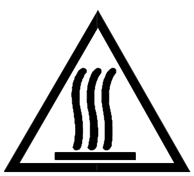
> **Caution.** Inspect the APCI probe. Make sure that the green ground wire is not touching the vaporizer casing. Reposition the ground wire if necessary.

4. Slide the APCI probe assembly onto the probe slide adapter. Secure the APCI probe assembly to the probe slide adapter with the knurled fastener.
5. Push the APCI probe assembly against the spray shield.
6. Secure the APCI flange to the spray shield with the two flange retainer bolts.
7. Connect the sample transfer line and fitting to the inlet labeled *LC* on the APCI probe.
8. Connect the auxiliary gas line and (green) fitting to the inlet labeled *A* on the APCI probe.
9. Connect the sheath gas line and (blue) fitting to the inlet labeled *S* on the APCI probe.
10. Connect the high voltage cable to the connector on the APCI probe assembly. Turn the locking-ring on the cable clockwise to secure the cable.
11. Connect the vaporizer heater cable to the connector on the front panel of the MS detector (beneath the APCI probe assembly). Make sure that the red dot on the cable is aligned with the red mark on the connector.

## 2.4 Removing the APCI Probe Assembly

To remove the APCI probe assembly, proceed as follows:

1. Stop the flow of sample solution (from the LC or syringe pump) into the APCI probe.
2. Disconnect the corona needle high voltage cable from the corona needle high voltage connector. To disconnect the cable, turn the locking ring on the cable counterclockwise until you can pull the cable free.
3. Disconnect the vaporizer heater cable from the connector on the front panel. (Leave the cable connected to the APCI flange.) To disconnect the cable, pull back on the locking ring on the cable.
4. Disconnect the sample transfer line from the APCI probe.
5. Disconnect the sheath gas line from the APCI probe.
6. Disconnect the auxiliary gas line from the APCI probe.



**CAUTION.** The APCI vaporizer heater can reach temperatures of 800 °C. Always allow the APCI probe to cool to ambient temperatures before handling it.

7. Loosen the two flange retainer bolts that secure the APCI probe assembly to the API spray shield.
8. Pull back the APCI probe assembly from the spray shield.
9. With one hand holding the APCI flange, loosen the knurled fastener that secures the APCI flange to the probe slide adapter.
10. Remove the APCI probe assembly from the probe slide adapter by sliding it off the probe slide adapter. Place the APCI probe assembly on a lint-free tissue.
11. Remove the corona discharge needle from the APCI probe assembly by pulling it free from the corona discharge needle assembly. Store the corona discharge needle by inserting it into one of the foam walls of the APCI probe assembly storage container.
12. Store the APCI probe assembly in its foam storage container. (Make sure that the APCI probe assembly is at ambient temperature before you place it in its storage container.)

# Chapter 3

# System Shutdown, Startup, and Reset

Many maintenance procedures for the LCQDECA system require that the MS detector be shut down completely. In addition, the LCQDECA can be placed in Standby condition if the system is not to be used for 12 hours or more.

The following topics are discussed in this chapter:

- Shutting down the system in an emergency
- Placing the system in Standby condition
- Shutting down the system completely
- Starting up the system after a complete shutdown
- Reseting the MS detector
- Reseting the tune and calibration parameters to their default values
- Turning off selected MS detector components

## 3.1 Shutting Down the System in an Emergency

If you need to turn off the MS detector in an emergency, place the main power circuit breaker switch (located on the power panel on the right side panel of the MS detector) in the Off (O) position. See Figure 3-1. This turns off all power to the MS detector, including the vacuum pumps. Although removing power abruptly will not harm any component within the system, this is not the recommended shutdown procedure to follow. Refer to the topic **Shutting Down the System Completely**, for the recommended procedure.

To turn off the LC, autosampler, and computer in an emergency, use the on/off switches on the LC, autosampler, and computer, respectively.

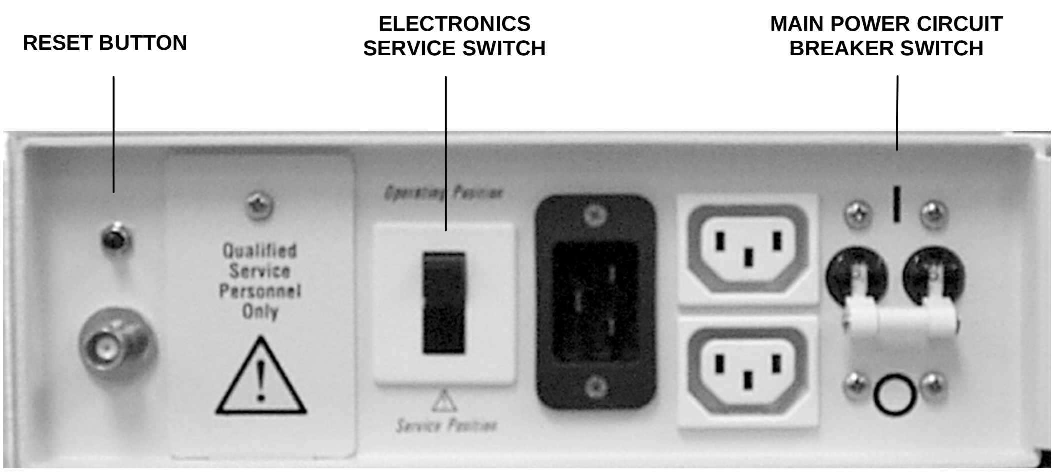



**Figure 3-1. Power panel, showing the Reset button, electronics service switch, and the main power circuit breaker switch**

## 3.2 Placing the System in Standby Condition

The LCQDECA system does not need to be shut down completely if you are not going to use it for a short period of time, such as overnight or over weekends. When you are not going to operate the system for 12 hours or more, you can leave the system in a Standby condition.

Use the following procedure to place the LCQDECA system in the Standby condition:

1. Wait until data acquisition, if any, is complete.
2. Turn off the flow of sample solution from the LC (or other sample introduction device).

> **Note.** For instructions on how to operate the LC from the front panel, refer to the manual that came with the LC.

3. From the Tune Plus window, choose **Control | Standby** (or click on the On/Standby button) to put the MS detector in Standby condition. When you choose Control | Standby, the LCQDECA turns off the electron multiplier, conversion dynode, 8 kV power to the API source, ring electrode RF voltage, and octapole RF voltage. The LCQDECA also turns off the auxiliary gas and sets the sheath gas flow to 0 units. See Table 3-1 on page 3-11 for the On/Off status of MS detector components when the MS detector is in the Standby condition. The System LED on the front panel of the MS detector is illuminated yellow when the system is in Standby condition.
4. Flush the spray shield and the entrance end of the heated capillary of the API source as describe in the topic **Flushing the Spray Shield and Heated Capillary** in the **User Maintenance** chapter. Cap the heated capillary with the septum. Leave the API flange withdrawn from the spray shield.
5. Purge the rotary-vane pump oil as described in the topic **Purging the Oil in the Rotary-Vane Pumps** in the **User Maintenance** chapter.
6. Leave the MS detector power on.
7. Leave the LC power on.
8. Leave the autosampler power on.
9. Leave the data system power on.

## 3.3 Shutting Down the System Completely

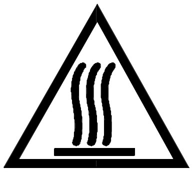
The LCQDECA system does not need to be shut down completely if you are not going to use it for a short period of time, such as overnight or over a weekend. (See the topic **Placing the System in Standby Condition**, above.) Shut down the system completely only if it is to be unused for an extended period or if it must be shut down for a maintenance or service procedure.

Use the following procedure to shut down the LCQDECA system completely:

1. Turn off the flow of sample solution from the LC (or other sample introduction device).

> **Note.** For instructions on how to operate the LC from the front panel, refer to the manual that came with the LC.

2. From the Tune Plus window, choose **Control | Off** to put the MS detector in Off condition. When you choose Control | Off, the LCQDECA turns off all high voltage, and the sheath and auxiliary gas.
3. Place the electronics service switch, located on the power panel (see Figure 3-1 on page 3-2), in the Service Position. Power to the non-vacuum system electronics is turned off when you place the electronics service switch in the Service Position.
4. Place the main power circuit breaker switch, located on the power panel (see Figure 3-1) in the Off (O) position. When you place the main power circuit breaker switch in the Off (O) position, the following occurs:
   - All power to the MS detector, including the turbomolecular pump and the rotary-vane pumps, is turned off. (All LEDs on the front panel of the MS detector are off.)
   - The battery backup on the Vent Delay PCB provides power to the vent valve for 30 s. After 30 s, a circuit on the Vent Delay PCB times out, and power to the vent valve solenoid is shut off. When power to the vent valve solenoid is shut off, the vent valve opens and the vacuum manifold is vented to atmosphere through a filter. You can hear a hissing sound as the air passes through the air filter.
   - After about 2 min, the vacuum manifold is at atmospheric pressure.



**CAUTION.** Allow heated components to cool before you service them.

**Note.** If you are planning to perform routine or preventive system maintenance on the MS detector only, you do not need to turn off the LC, autosampler, and data system. In this case, the shutdown procedure is completed. However, if you do not plan to operate your system for an extended period of time, we recommend that you turn off the LC, autosampler, and data system.

# 3.4 Starting Up the System after a Complete Shutdown

To start up the LCQDECA system after it has been shut down completely, you need to do the following:

- Start up the MS detector
- Set up conditions for operation

## Starting Up the MS Detector

Use the following procedure to start up the MS detector:

> **Note.** The LC, autosampler, and data system must be running before you start up the MS detector. The MS detector will not operate until software is received from the data system.

1. Turn on the flows of helium and nitrogen at the tanks if they are off.
2. Make sure that the main power circuit breaker switch is in the Off (O) position and the electronics service switch is in the Service Position.
3. Place the main power circuit breaker switch in the On (|) position. When you place the main power circuit breaker switch in the On (|) position, the rotary-vane pump and the turbomolecular pump are started. All LEDs on the MS detector front panel are off.
4. Place the electronics service switch in the Operating Position. When you place the electronics service switch in the Operating Position, the following occurs:
   - The Power LED on the MS detector front panel is illuminated green to indicate that power is provided to the MS detector electronics. (The electron multiplier, conversion dynode, 8 kV power to the API source, main RF voltage, and octapole RF voltage remain off.)
   - The embedded computer reboots. After several seconds, the Communication LED on the front panel is illuminated yellow to indicate that the data system and the MS detector have started to establish a communication link.
   - After several more seconds, the Communication LED is illuminated green to indicate that the data system and the MS detector have established a communication link. Software for the operation of the MS detector is then transferred from the data system to the MS detector.

- After 3 min, the System LED is illuminated yellow to indicate that the software transfer from the data system to the MS detector is complete and that the instrument is in Standby condition.

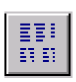
> **Note.** The Vacuum LED on the front panel of the MS detector is illuminated green only if the pressure in the vacuum manifold is below the maximum allowable pressure ($5 \times 10^{-4}$ Torr in the analyzer region, and 2 Torr in the capillary-skimmer region), and the safety interlock switch on the API source is depressed (that is, the API flange is secured to the spray shield).

## Setting Up Conditions for Operation

Set up your LCQDECA for operation, as follows:

1. Before you begin data acquisition with your LCQDECA system, you need to allow the system to pump down for at least 1 hour. Operation of the system with excessive air and water in the vacuum manifold can cause reduced sensitivity, tuning problems, and a reduced lifetime of the electron multiplier.
2. Ensure that the helium pressure and nitrogen pressure are within the operational limits (helium: 40 ±10 psig [275 ±70 kPa], nitrogen: 100 ±20 psig [690 ±140 kPa]).

> **Note.** Air in the helium line must be purged or given sufficient time to be purged for normal LCQDECA performance



3. Select the Status View button in the Tune Plus window. Check to see if the pressure measured by the ion gauge is below about $5 \times 10^{-5}$ Torr, and the pressure measured by the Convectron gauge is around 1 Torr. Compare the values of the other parameters in the status panel with values that you recorded previously.
4. Continue to set up for ESI or APCI operation as you normally do.

## 3.5 Resetting the MS Detector

If communication between the MS detector and data system computer is lost, it may be necessary to reset the MS detector using the Reset button on the power panel.

The procedure given here assumes that the MS detector and data system computer are both powered on and are operational. If the MS detector, data system computer, or both are off, refer to the topic **Starting Up the System after a Complete Shutdown**.

To reset the MS detector, press the Reset button located on the power panel. See Figure 3-1 on page 3-2 for the location of the Reset button. When you press the Reset button, the following occurs:

- An interupt on the CPU PCB of the embedded computer causes the embedded computer to reboot. All LEDs on the front panel of the MS detector are off except the Power LED.
- After several seconds, the Communication LED is illuminated yellow to indicate that the data system and the MS detector are starting to establish a communication link.
- After several more seconds, the Communication LED is illuminated green to indicate that the data system and the MS detector have established a communication link. Software for the operation of the MS detector is then transferred from the data system to the MS detector.
- After 3 min, the software transfer is complete. The System LED is illuminated either green to indicate that the instrument is functional and the high voltages are on or yellow to indicate that the instrument is functional and it is in Standby condition.

## 3.6 Resetting the Tune and Calibration Parameters to their Default Values

You can reset the LCQDECA tune and calibration parameters to their default values at any time. This feature may be useful if you have manually set some parameters that have resulted in less than optimum performance. To reset the LCQDECA tune and calibration parameters to their default values, proceed as follows: In the Tune Plus window, choose **File | Restore Factory Calibration** to restore the default calibration parameters, or choose **File | Restore Factory Tune Method** to restore the default tune parameters.

> **Note.** Make sure that the problems that you might be experiencing are not due to improper API source settings (spray voltage, sheath and auxiliary gas flow, heated capillary temperature, etc.) before resetting the system parameters to their default values.

# 3.7 Turning Off Selected MS Detector Components

There are five ways that you can turn off some or all of the MS detector components:

- Turn off individual MS detector components from the Tune Plus window. Turning off individual MS detector components may be necessary when you are troubleshooting or when you are running certain diagnostic procedures.
- Place the MS detector in Standby condition. Standby is the normal condition to leave the MS detector in when it is not in use. Choose **Control | Standby** (or toggle the On/Standby button) from the Tune Plus window to place the MS detector in Standby condition.
- Place the MS detector in the Off condition. The Off condition is similar to Standby condition, except all high voltage components of the MS detector are turned off. Choose **Control | Off** from the Tune Plus window to place the MS detector in the Off condition.
- Place the electronics service switch in the Service Position. The electronics service switch allows you to perform maintenance procedures involving non-vacuum system components of the MS detector.
- Place the main power circuit breaker switch in the Off (O) position. Placing the main power circuit breaker switch in the Off (O) position removes all power to the MS detector, including the vacuum system.

The on/off status of MS detector components, voltages, and gas flows is summarized in Table 3-1.

**Table 3-1. On/Off status of MS detector components, voltages, and gas flows**

| MS Detector Component | Standby | Off | Electronics Service Switch in Service Position | Main Power Circuit Breaker Switch in Off (O) Position |
|---|---|---|---|---|
| **Electron multiplier** | Off | Off | Off | Off |
| **Conversion dynode** | Off | Off | Off | Off |
| **Mass analyzer RF/waveform voltages** | Off | Off | Off | Off |
| **Mass analyzer dc offset voltage** | **On** | Off | Off | Off |
| **Multipole RF voltage** | Off | Off | Off | Off |
| **Multipole dc offset voltage** | **On** | Off | Off | Off |
| **Interoctapole lens** | **On** | Off | Off | Off |
| **Tube lens** | **On** | Off | Off | Off |
| **Heated capillary heater** | **On** | **On** | Off | Off |
| **Heated capillary dc offset** | **On** | Off | Off | Off |
| **Corona discharge needle** | Off | Off | Off | Off |
| **APCI vaporizer** | Off | Off | Off | Off |
| **ESI needle** | Off | Off | Off | Off |
| **Sheath gas** | Off | Off | Off | Off |
| **Auxiliary gas** | Off | Off | Off | Off |
| **Helium damping gas** | **On** | **On** | **On** | **On** |
| **Vent valve** | Closed | Closed | Closed | **Open** (after 30 s) |
| **Turbomolecular pump** | **On** | **On** | **On** | Off |
| **Rotary-vane pump** | **On** | **On** | **On** | Off |
| **Vent Delay PCB** | **On** | **On** | **On** | Off (after 30 s) |
| **Embedded computer** | **On** | **On** | Off | Off |
| **Turbomolecular Pump Controller** | **On** | **On** | **On** | Off |
| **Power supply, electron multiplier** | Off | Off | Off | Off |
| **Power supply, conversion dynode** | Off | Off | Off | Off |
| **Power supply, 8 kV** | Off | Off | Off | Off |
| **Power supply, +5, ±15, +24 V dc switching** | **On** | **On** | Off | Off |
| **Power supply, +36, -28 V dc switching** | **On** | Off | Off | Off |

**Table 3-1. On/Off status of MS detector components, voltages, and gas flows (continued)**

| | | | | |
|---|---|---|---|---|
| **Power supply, +24 V dc keep alive** | **On** | **On** | **On** | Off |
| **Power supply, +180 V dc** | **On** | **On** | Off | Off |
| **Power supply, ±150 V dc** | **On** | Off | Off | Off |
| **Power supply, +36 V dc** | **On** | Off | Off | Off |
| **Power supply, ±20 V dc** | **On** | **On** | Off | Off |
| **Power supply, ±205 V dc** | **On** | Off | Off | Off |
| **Power supply, 24 V ac** | **On** | **On** | Off | Off |
| **Power supply, 4 V ac** | **On** | **On** | Off | Off |
| **Fan, turbomolecular pump** | **On** | **On** | **On** | Off |
| **Fan, RF coil** | **On** | **On** | Off | Off |
| **Fans, tower** | **On** | **On** | Off | Off |
| **Fan, embedded computer** | **On** | **On** | Off | Off |
| **Convectron gauge** | **On** | **On** | Off | Off |
| **Ion gauge** | **On** | **On** | Off | Off |
| **Syringe pump** | ***On** | ***On** | Off | Off |

*The syringe pump goes from On to Off only when the system goes from scan mode to Standby condition

# Chapter 4

# User Maintenance

LCQDECA performance depends on the maintenance of all parts of the instrument. **It is your responsibility to maintain your system properly by performing the system maintenance procedures on a regular basis**.

This chapter describes routine API source maintenance procedures that must be performed to ensure optimum performance of the instrument. Routine and infrequent maintenance procedures are listed in Table 4-1.

**Table 4-1. User maintenance procedures**

| MS Detector Component | Procedure | Frequency | Procedure Location |
|---|---|---|---|
| API source | Flush (clean) sample transfer line, sample tube, and API probe | Daily | Page 4-5 |
| API source | Flush (clean) heated capillary | Daily (or more often*) | Page 4-6 |
| API source | Flush (clean) spray shield | Daily (or more often*) | Page 4-6 |
| Rotary-vane pumps | Purge (decontaminate) oil | Daily | Page 4-34 |
| API source | Clear heated capillary | If heated capillary bore is obstructed | Page 4-7 |
| API source | Replace heated capillary | If heated capillary bore is corroded or if heater fails | Page 4-30 |
| API source | Clean API stack (spray shield, heated capillary, tube lens, and skimmer) | As needed* | Page 4-31 |
| API source | Replace sample tube | If sample tube is broken or obstructed | Pages 4-10 (ESI) and 4-24 (APCI) |
| Cooling fans | Clean fan filter | Every 4 months | Page 4-35 |
| Rotary-vane pumps | Add oil | If oil level is low | Manufacturer's documentation |
| Rotary-vane pumps | Change oil | Every 3 months or if oil is cloudy or discolored | Manufacturer's documentation |

*Frequency depends on analytical conditions

For instructions on maintaining LCs or autosamplers, refer to the manual that comes with the LC or autosampler.

The topics included in this chapter are as follows:

- Tools and supplies
- Frequency of cleaning
- API source maintenance
- Purging the oil in the rotary-vane pumps
- Cleaning the fan filter

**Note.** The keys to success with the procedures in this chapter are:

- Proceed methodically
- Always wear clean, lint-free gloves when handling the components of the API source
- Always place the components on a clean, lint-free surface
- Never overtighten a screw or use excessive force

# 4.1 Tools and Supplies

The LCQDECA requires very few tools for you to perform routine maintenance procedures. You can remove and disassemble many of the components by hand. The tools, equipment, and chemicals listed in Table 4-2 are needed for the maintenance of the API source.

**Table 4-2. Tools, equipment, and chemicals**

| Description | Part Number |
|---|---|
| Wrench, 5/16-in., hex socket (Allen) | |
| Wrench, 9/16-in., socket | |
| Wrench, 7/16-in., open end | |
| Wrench, 9/16-in., open end | |
| Wrench, 5/16-in., open end | |
| Wrench, 1/2-in., open end | |
| Wrench, 3/8-in., open end | |
| Screwdrivers, set, ball point, Allen (also referred to as ball drivers) | 00025-03025 |
| Screwdriver, slot head, large | |
| Screwdriver, slot head, small | |
| Screwdriver, Phillips, small | |
| Fused-silica cutting tool | |
| Hypodermic tube | 00106-20000 |
| Spray bottle | |
| Beaker, 450 mL | |
| Gloves, nylon | 00301-09700 |
| Kimwipes® or other lint-free industrial tissue | |
| Applicators (swabs), cotton-tipped | 00301-02000 |
| Detergent | |
| Clean, dry, compressed nitrogen gas | |
| Distilled water | |
| Methanol, HPLC grade or better | |

## 4.2 Frequency of Cleaning

**CAUTION.** As with all chemicals, solvents and reagents should be stored and handled according to standard safety procedures and should be disposed of according to local and federal regulations.

The frequency of cleaning the components of the MS detector depends on the types and amounts of samples and solvents that are introduced into the instrument. In general, for a given sample and ionization technique, the closer an MS detector component is to the source of the ions, the more rapidly it becomes dirty.

- The sample tube, API probe, heated capillary bore, and spray shield of the API source should be cleaned at the end of each operating day to remove any residual salts from buffered mobile phases or other contamination that might have accumulated during normal operation. Refer to the topics **Flushing the Sample Transfer Line, Sample Tube, and API Probe** and **Cleaning the Spray Shield and the Heated Capillary** on pages 4-5 and 4-6.
- The tube lens and skimmer of the API source become dirty at a slower rate than the API probe, spray shield, and heated capillary. Refer to the topic **Maintaining the API Stack** on pages 4-27.

When the performance of your system decreases significantly because of contamination, clean the components of the MS detector in the following order:

- Clean the API probe, spray shield, and heated capillary
- Clean the tub lens and skimmer
- Clean the ion optics and mass analyzer (see Chapter 5)

# 4.3 API Source Maintenance

The API source requires a minimum of maintenance. Periodically, you need to clean the components of the API source to remove salts or other contaminants. The frequency of cleaning the API source depends on the types and amounts of samples and solvents that are introduced into the system.

Maintenance procedures are provided below to do the following:

- Flushing the sample transfer line, sample tube, and API probe
- Cleaning the spray shield and the heated capillary
- Cleaning the bore of the heated capillary
- Maintaining the ESI probe
- Maintaining the APCI probe
- Maintaining the API stack

**CAUTION. AVOID EXPOSURE TO POTENTIALLY HARMFUL MATERIALS**. Always wear protective gloves and safety glasses when you use solvents or corrosives. Also, contain waste streams and use proper ventilation. Refer to your supplier's Material Safety Data Sheets (MSDS) for procedures that describe how to handle a particular solvent.

## Flushing the Sample Transfer Line, Sample Tube, and API Probe

You should flush the sample transfer line, sample tube, and API probe at the end of each working day (or more often if you suspect they are contaminated) by flowing a 50:50 methanol:distilled water solution from the LC through the API source.

To flush the sample transfer line, sample tube, and API probe, proceed as follows:

1. Make sure that the API flange is secured to the spray shield by the two flange retainer bolts.
2. Let the solution flow through the sample transfer line, sample tube, and API probe for 15 min. After 15 min, turn off the flow of liquid from the LC to the API source. Leave the API source (including the APCI vaporizer, sheath gas, and auxiliary gas) on for an additional 5 min.

# Cleaning the Spray Shield and the Heated Capillary

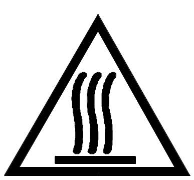
You need to clean the spray shield and the heated capillary on a regular basis to maintain optimum performance of your API source. A good practice is to flush the spray shield and heated capillary at the end of each operating day (after you flush the sample transfer line, sample tube, and API probe) with a 50:50 methanol:water solution from the LC. If you are operating the system with nonvolatile buffers in your solvent system or high concentrations of sample, you may need to clean the spray shield and heated capillary more often.

You do not have to vent the system to flush the spray shield and heated capillary. To clean the spray shield and the heated capillary, proceed as follows:

1. Turn off the flow of liquid from the LC (or other sample introduction device) to the API source.
2. Place the MS detector in Off condition.

**CAUTION.** Place the MS detector in Off condition before you open the atmospheric pressure ionization (API) source. The presence of atmospheric oxygen in the API source when the MS detector is On could be unsafe. (LCQDECA automatically turns the MS detector Off when you open the API source, however, it is best to take this added precaution.)

3. Loosen the two flange retainer bolts that secure the API flange (ESI or APCI flange) to the spray shield.
4. Pull back the API flange from the spray shield.



**CAUTION. AVOID BURNS. At operating temperatures, the APCI vaporizer and heated capillary can severely burn you!** The APCI vaporizer typically operates at 400 to 600 °C and the heated capillary typically operates at 100 to 350 °C. Allow the heated vaporizer and heated capillary to cool to room temperature, for approximately 20 min, before you touch or remove either component.

5. Temporarily place a large Kimwipe (or other lint-free tissue) at the bottom of the spray shield. (The Kimwipe is required to absorb the solution used to flush the heated capillary and spray shield.)

6. Fill a spray bottle with a 50:50 solution of HPLC-grade methanol:distilled water. Spray approximately 5 mL of the solution at the opening of the heated capillary. Do not touch the heated capillary with the tip of the spray bottle.
7. Use the spray bottle filled with the 50:50 solution of HPLC-grade methanol:distilled water to flush contaminants from the interior surface of the spray shield.
8. Remove the Kimwipe you used to absorb the solution. Swab the surface of the spray shield with a dry Kimwipe.
9. Ensure that you have removed any salt or other contaminants that may have been deposited on the spray shield.
10. If you are operating in the ESI mode, wipe off the ESI spray nozzle with a Kimwipe soaked with the methanol:water solution.

**Note.** If you are finished operating your LCQDECA for the day, cap the heated capillary with the septum. Leave the API flange withdrawn from the spray shield.

## Clearing the Bore of the Heated Capillary

The bore of the heated capillary can become blocked by buffer salts or high concentrations of sample. A stainless steel hypodermic tube has been included in your accessory kit for clearing a blocked heated capillary.

If the pressure in the capillary-skimmer region (as measured by the Convectron gauge) drops considerably below 0.8 Torr, you should suspect a blocked heated capillary.

You do not have to vent the system to clear the bore of the heated capillary. To clear the bore of the heated capillary, proceed as follows:

1. Turn off the flow of liquid from the LC to the API source.
2. Place the MS detector in Off condition.

**CAUTION.** Place the MS detector in Off condition before you open the atmospheric pressure ionization (API) source. The presence of atmospheric oxygen in the API source when the MS detector is On could be unsafe. (LCQDECA automatically turns the MS detector Off when you open the API source, however, it is best to take this added precaution.)

3. Loosen the two flange retainer bolts that secure the API flange (ESI or APCI) to the spray shield.
4. Pull back the API flange from the spray shield.

**CAUTION.** Before you proceed, make sure that the LCQDECA has sensed that the ion source flange has been opened and has deactivated the high voltage power supplies. In the Tune Plus window choose **View | Status View**, then check the following readings:

1. ESI SOURCE: Spray Voltage (kV) is at-or-near 0.0 V
2. VACUUM OK: reads FALSE
3. POWER SUPPLIES:
   −150V Supply Voltage (V) is at-or-near 0.0 V
   +150V Supply Voltage (V) is at-or-near 0.0 V
   −205V Supply Voltage (V) is at-or-near 0.0 V
   +205V Supply Voltage (V) is at-or-near 0.0 V

**CAUTION. AVOID BURNS. At operating temperatures, the APCI vaporizer and heated capillary can severely burn you!** The APCI vaporizer typically operates at 400 to 600 °C and the heated capillary typically operates at 100 to 350 °C. Allow the heated vaporizer and heated capillary to cool to room temperature, for approximately 20 min, before you touch or remove either component.

5. Clear the bore of the heated capillary by inserting and withdrawing the 28-gauge, 10-in hypodermic tube (P/N 00106-20005) included in your accessory kit.
6. Fill a spray bottle with a 50:50 solution of HPLC-grade methanol:distilled water. From a distance of 10 cm from the entrance end of the heated capillary, spray a small amount of the solution down the bore of the heated capillary.
7. Repeat steps 5 and 6 several times, if necessary.

**Note.** If you have unblocked the heated capillary, the Convectron gauge pressure should increase to a normal value (approximately 1 Torr). If you can not clear the heated capillary by this method, use the instructions for removing the heated capillary from the spray shield in the topic **Maintaining the API Stack** on page 4-27. Then, try clearing the heated capillary from the exit end by the same method.

8. Push the API flange assembly against the spray shield.
9. Secure the API flange to the spray shield with the two flange retainer bolts.

# Maintaining the ESI Probe

The ESI probe may be fitted with either a fused-silica sample tube or an optional blunt-tip, 32-gauge stainless steel needle. The 0.100-mm ID × 0.190-mm OD fused-silica sample tube (P/N 00106-10499) is supplied in the standard API2 Accessory Kit (P/N 70005-60109). The blunt-tip, 32-gauge stainless steel needle (P/N 00950-00954) is supplied in the optional API2 Metal Needle Kit (P/N 70005-62013).

If the fused-silica sample tube or stainless steel needle becomes blocked or broken, you need to replace it. You can replace the sample tube or the stainless steel needle without disassembling the ESI probe. However, to clean interior surfaces, replace the ESI spray needle or needle seal, you need to disassemble the ESI probe.

**Note.** You should flush the ESI probe at the end of each working day by flowing a 50:50 methanol:water solution from the LC through the ESI probe. Refer to the topic **Flushing the Sample Transfer Line, Sample Tube, and API Probe** on page 4-5.

**Note.** Wear clean gloves when you handle ESI probe components.

The following procedures are discussed in this topic:

- Removing the ESI probe assembly
- Disassembling the ESI probe assembly
- Removing the ESI spray nozzle, ESI spray needle, and needle seal
- Cleaning the ESI manifold
- Cleaning the ESI spray nozzle
- Reassembling the ESI probe assembly
- Reinstalling the ESI probe
- Reinstalling the ESI probe assembly

## Removing the ESI Probe Assembly

Remove the ESI probe assembly from the LCQDECA as described in the topic **Removing the ESI Probe Assembly** in the chapter **Changing ESI or APCI Probe Assemblies**.

## Disassembling the ESI Probe Assembly

The ESI probe is disassembled as described in the following topics:

- Disassembling an ESI probe assembly fitted with a fused-silica sample tube
- Disassembling an ESI probe assembly fitted with a stainless steel needle

### *Disassembling an ESI Probe Assembly Fitted with a Fused-Silica Sample Tube*

To disassemble an ESI probe assembly fitted with a fused-silica sample tube, proceed as follows:

1. Disconnect the PEEK safety sleeve and fused-silica sample tube from the ESI probe sample inlet, as follows:
   a. Unscrew the (clear) 10-32 × 1/4-28 Kel-F fitting adapter from the ESI probe sample inlet. The PEEK safety sleeve and (red) Fingertight fitting remain attached.
   b. Remove the PEEK safety sleeve, Fingertight fitting, and Kel-F fitting adapter from the ESI probe by carefully pulling them out and away from the ESI probe. The fused-silica sample tube is visible as the PEEK safety sleeve is pulled out.
2. Loosen the probe retainer thumbscrew that holds the ESI probe in the ESI flange. Remove the ESI probe by pulling the ESI probe toward the interior (spray chamber side) of the ESI flange.

If you want to clean the interior surface of the ESI probe, go to the topic **Removing the ESI Spray Nozzle, ESI Spray Needle, and Needle Seal**.

If you only want to replace the ESI sample tube, go to the topic **Reassembling the ESI Probe Assembly**.

### *Disassembling an ESI Probe Assembly Fitted with a Stainless Steel Needle*

To disassemble an ESI probe assembly fitted with a stainless steel needle, proceed as follows:

1. Remove the stainless steel needle from the ESI probe, as follows:
   a. Unscrew the (clear) 10-32 × 1/4-28 Kel-F fitting adapter from the ESI probe sample inlet. The stainless steel needle, (brown) PEEK adapter union, (black) LC union, and Metal Needle Safety Insulator remain attached.
   b. Remove the Kel-F fitting adapter and the stainless steel needle by pulling them out and away from the ESI probe.

2. Loosen the probe retainer bolt that holds the ESI probe in the ESI flange and remove the ESI probe by pulling the ESI probe toward the interior (spray chamber side) of the ESI flange.

If you want to clean the interior surface of the ESI probe, go to the next topic: **Removing the ESI Spray Nozzle, ESI spray Needle, and Needle Seal**.

If you want to replace the stainless steel needle, go to step 7 of the topic **Reassembling the ESI Probe Assembly Fitted with a Stainless Steel Needle**.

## Removing the ESI Spray Nozzle, ESI Spray Needle, and Needle Seal

You need to replace the ESI spray needle if it is damaged. You need to replace the Teflon® needle seal if the sheath liquid is leaking at the needle seal-spray needle interface.

To remove the ESI spray nozzle, ESI spray needle, and needle seal, proceed as follows. See Figure 4-1.

1. Use a 5/16-in. wrench to loosen and remove the spray nozzle from the ESI manifold. Remove the O-ring for cleaning.

> **Note.** To ease removal of the spray nozzle from the ESI manifold, lubricate the threads of the spray nozzle by spraying approximately 0.5 mL HPLC-grade methanol into the auxiliary gas holes on the spray nozzle. Do not apply unnecessary force to remove the spray nozzle.

2. Remove the spray needle and needle seal from the ESI manifold. To remove the needle seal, use the Teflon seal extractor tool (P/N 70005-20304, provided in the Accessories Kit). Introduce the extractor tool from the back end of the ESI probe and push out the needle seal.

## Cleaning the ESI Manifold

During high flow rate operation (e.g., 0.05 to 1.0 mL/min), if the nitrogen sheath and auxiliary gases are not used, the power supply for the ESI voltage may not be able to reach the level you set it to. This problem is a result of the formation of current leakage paths on the ESI probe. The two zones where leakage paths can occur are the following:

- Between the ESI spray nozzle and the grounded ESI flange
- In the high voltage connector within the ESI probe

In the first case, disassembly of the probe is not necessary. To remove this leakage path, simply dry the wet PEEK surface of the ESI probe with a Kimwipe. If this does not resolve the leakage problem, then a leak in the high voltage connector within the probe is the likely cause of the problem. In this case, you need to disassemble and dry the ESI manifold.

To clean and dry the ESI manifold, proceed as follows. See Figure 4-1.

1. If you have not already done so, disassemble the ESI probe assembly following the procedure described in the topic **Disassembling the ESI Probe Assembly** earlier in this chapter.
2. If you have not already done so, use a 5/16-in. wrench to remove the ESI spray nozzle from the ESI manifold.
3. Remove the compression spring from the ESI manifold (from where it was seated behind the spray nozzle) and place it on a clean surface (e.g., a clean Kimwipe or other lint-free towel).
4. Using a Phillips screwdriver, remove the 4-40 × 3/4-in. stainless steel screw used to make the high voltage connection to the compression spring. Ensure that the O-ring around the screw is also removed. Place both of these parts on a clean surface.
5. Using a 1/2-in. wrench, remove the high voltage connector from the manifold. Be sure to keep track of the compression spring that makes the electrical connection between the HV connector and the 4-40 screw. If the spring does not fall out of the assembly, gently use the Teflon seal extractor tool (P/N 70005-20304, provided in the Accessories Kit), or another appropriate tool, to get the spring out. Place these parts on a clean surface.
6. Rinse the ESI manifold with distilled water and then with HPLC-grade methanol. Use a Kimwipe to remove excess methanol from the ESI manifold.
7. Dry the ESI manifold with nitrogen gas.
8. Inspect all of the O-rings and replace any that are damaged.
9. Replace the Phillips screw and O-ring (that you removed in step 4) in the ESI manifold.
10. Place the compression spring (that you removed in step 5) into the high voltage passageway in the ESI manifold.
11. Replace and tighten the high voltage connector (along with the compression spring) onto the ESI manifold.

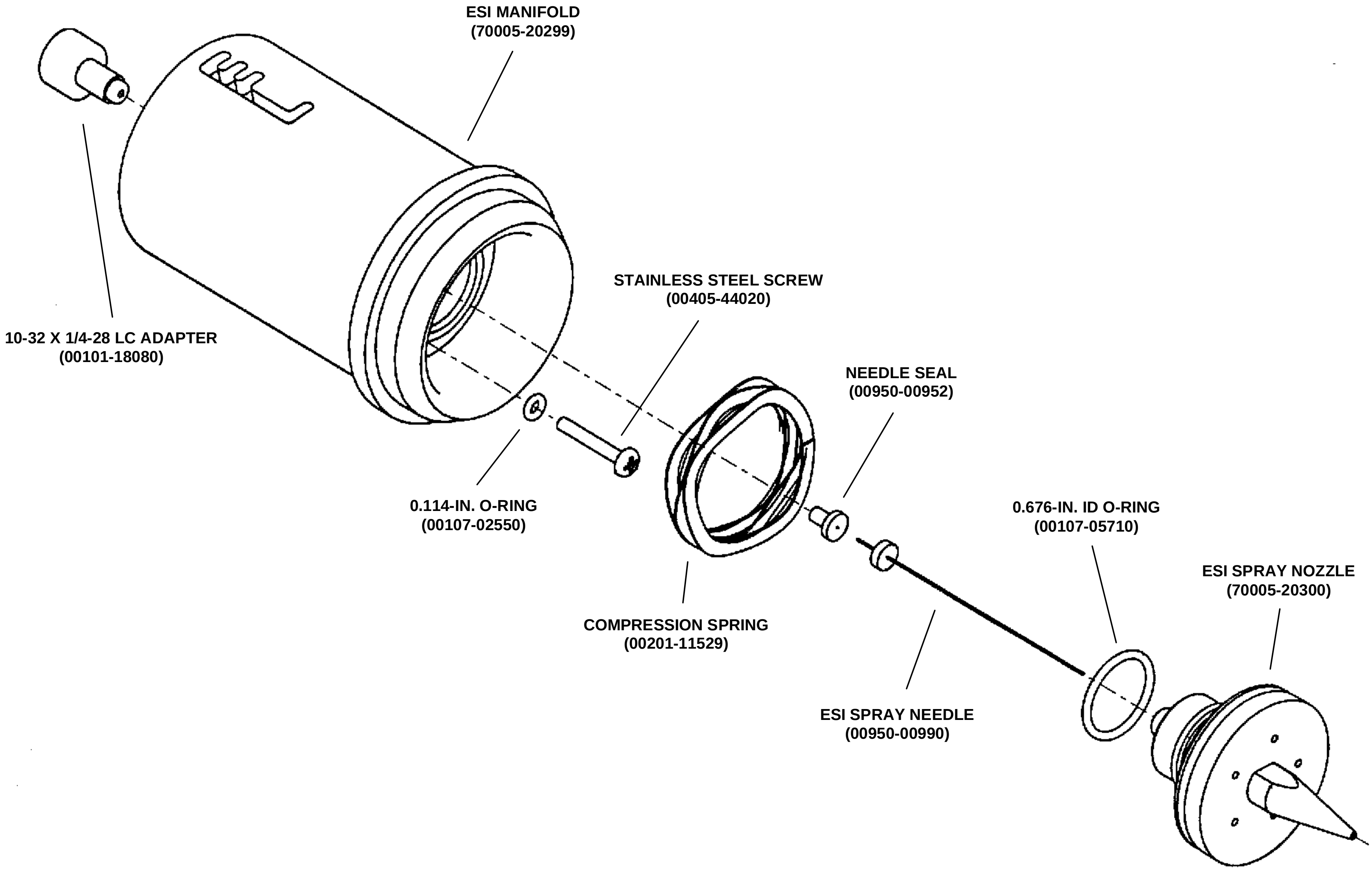



**Figure 4-1. ESI probe exploded view**

## Cleaning the ESI Spray Nozzle

If necessary, clean the bore of the ESI spray nozzle with an appropriate solvent. The solvent used will depend on the solubility of the chemical deposits. Then rinse the spray nozzle with HPLC-grade methanol and dry the spray nozzle with nitrogen gas.

## Reassembling the ESI Probe Assembly

The ESI probe may be reinstalled with either a fused-silica sample tube or a stainless steel needle, as described in the following topics:

- Reassembling the ESI probe assembly fitted with a PEEK safety sleeve and fused-silica sample tube
- Reassembling the ESI probe assembly fitted with a stainless steel needle

**CAUTION. AVOID ELECTRICAL SHOCK.** When you are operating your instrument in the ESI mode, there are two situations in which you could receive an electrical shock unless you install the safety kit discussed below. When you are using the optional Metal Needle Kit (P/N 70005-62013), you might receive an electrical shock if you touch the fused-silica capillary tube. You could also receive an electrical shock if the fused-silica capillary tube breaks during ESI operation, with or without the metal needle installed. Therefore, for your safety and in compliance with international safety standards, you **must** cover the fused-silica capillary tube with the PEEK safety sleeve (P/N 00301-22806) and associated PEEK ferrules (P/N 00101-18119) provided in the Safety Sleeve Kit (P/N 70005-62015) before you operate the instrument. Installation instructions (P/N 70005-97009) are included in the kit. Operation of the instrument without the safety sleeve impairs the safety protection provided by the instrument and, thus, could lead to serious injury.

### *Reassembling an ESI Probe Assembly Fitted with a PEEK Safety Sleeve and Fused-Silica Sample Tube*

To reassemble an ESI probe (that is, to reinstall the sample tube, ESI spray nozzle, ESI spray needle, and needle seal), proceed as follows:

1. Inspect the Teflon needle seal (P/N 00950-00952). If the needle seal is deformed, replace it.
2. Inspect the 26-gauge spray needle (P/N 00950-00990). If the spray needle is damaged, replace it.
3. Place the compression spring into the ESI manifold.

4. Ensure that the 0.676-in. ID O-ring (P/N 00107-05710) for the sheath gas on the spray nozzle is in good condition. In addition, ensure that the O-ring is placed into the pre-cut groove on the spray nozzle.
5. Reinstall the spray nozzle, spray needle, and needle seal, as follows:
   a. Insert the entrance end of the spray needle into the needle seal.
   b. Seat the spray needle and needle seal in the ESI manifold.
   c. Thread the spray nozzle over the needle and into the ESI manifold. Slightly wet the spray nozzle threads with HPLC-grade methanol for lubrication.
   d. With a 5/16-in. wrench, gently tighten the spray nozzle until it is a little more than finger-tight. Do not overtighten the spray nozzle.
6. Install the new sample tube and PEEK safety sleeve, as follows:
   a. Use a fused-silica cutting tool to cut a 30 cm (12-in.) piece of 0.1 mm ID × 0.19 mm OD fused-silica tubing (sample tube) (P/N 00106-10499). Ensure that you cut squarely the ends of the fused-silica tubing.
   b. Insert the sample tube through the exit end of the spray needle and into the ESI probe.
   c. Push the sample tube through the ESI probe until approximately 3.5 cm (1 1/2 in.) is left protruding from the exit end of the spray needle. The remaining length of sample tube should exit the ESI probe sample inlet (labeled *Sample*).
   d. Slide the (clear) 10-32 × 1/4-28 Kel-F fitting adapter (P/N 00101-18080) over the sample tube and tighten the fitting onto the ESI probe sample inlet.
   e. Slide the precut 25.4 cm (10 in.), 0.009 in. ID × 0.240 in. OD PEEK safety sleeve (P/N 00301-22806) over the sample tube.
   f. Slide the 0.027 in. ID PEEK ferrule (P/N 00101-18119), narrow end first, over the PEEK safety sleeve and to the 10-32 × 1/4-28 Kel-F fitting adapter.
   g. Slide the (red) Fingertight fitting (P/N 00101-18195) onto the PEEK safety sleeve and into the ESI probe sample inlet. Tighten the fitting slightly, but not completely.
   h. Ensure that the 2.0 in. ID Teflon O-ring (P/N 00107-18010), which seals the ESI probe to the ESI flange, is seated properly in the groove on the ESI flange.
   i. Pass the sample tube and PEEK safety sleeve through the ESI flange and install the ESI probe into the ESI flange.
   j. Pull the ESI probe back against the ESI flange. Tighten the probe retainer bolt that holds the ESI probe to the ESI flange.
   k. Push the PEEK safety sleeve over the sample tube until it stops against the Teflon needle seal inside the ESI probe.

l. Pull the sample tube (from the spray needle end) until the sample tube is flush with the precut square end of the PEEK safety sleeve.

m. Slide a (brown) Fingertight fitting (P/N 00101-18081) and (brown) ferrule (P/N 00101-18119), wide end first, over the PEEK safety sleeve.

n. Connect the PEEK safety sleeve and ferrule to the (stainless steel) grounded fitting by tightening the (brown) Fingertight fitting. Ensure that the Fingertight fitting is securely tightened around the PEEK safety sleeve, otherwise the sample stream might enter between the sample tube and the PEEK safety sleeve. Ensure the sample tube is held tightly in the grounded fitting by gently pulling the sample tube from the exit end of the spray needle.

o. Use a fused-silica cutting tool to cut the sample tube at the spray needle so that only 2.5 cm (1 in.) remains protruding from the exit end of spray needle. See Figure 4-2.

p. From the ESI sample inlet pull the PEEK safety sleeve backwards, so that the exit end of the sample tube is recessed just inside the spray needle by approximately 1 mm.

q. Tighten the (red) Fingertight fitting securely to hold the PEEK safety sleeve and sample tube in place.

> **Note.** The sample tube might move forward when you tighten the sample inlet fitting. Ensure that the sample tube is retracted into the spray needle approximately 1 mm. If necessary, loosen the fitting and reposition the sample tube.

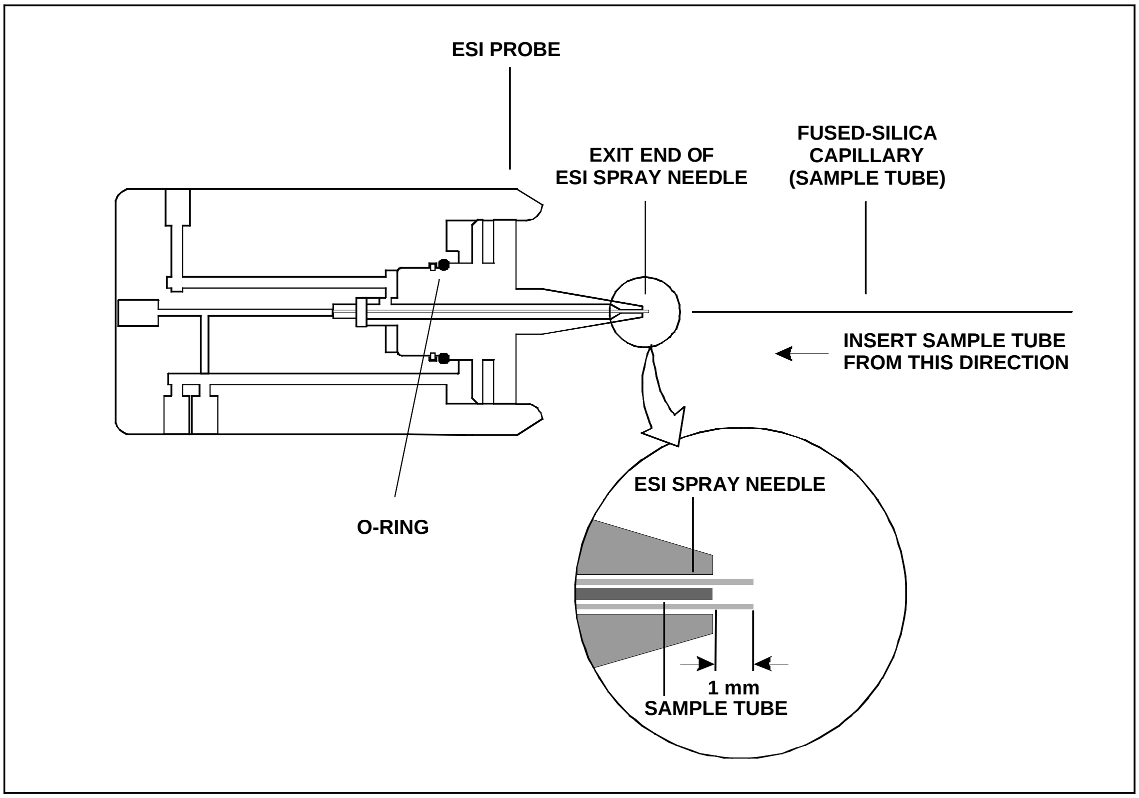



**Figure 4-2. Installing the ESI fused-silica sample tube**

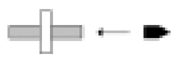
## *Reassembling the ESI Probe Assembly Fitted with a Stainless Steel Needle*

To reassemble the ESI probe (that is, to install the stainless steel needle, ESI spray nozzle, ESI spray needle, and needle seal), proceed as follows:

1. Inspect the Teflon needle seal (P/N 00950-00952). If the needle seal is deformed, replace it.
2. Inspect the 26-gauge spray needle (P/N 00950-00990). If the spray needle is damaged, replace it.
3. Place the compression spring into the ESI manifold.
4. Ensure that the 0.676-in. ID O-ring (P/N 00107-05710) for the sheath gas on the spray nozzle is in good condition. In addition, ensure that the O-ring is placed into the pre-cut groove on the spray nozzle. The reassembled spray nozzle will be used in step 6h.

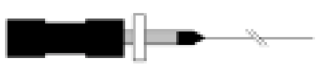
5. Reassemble the spray needle, and needle seal, as follows:
   a. Insert the entrance end of the spray needle into the needle seal.
   b. Seat the spray needle and needle seal in the ESI manifold.
6. Install the stainless steel needle, as follows:

> **Note.** Ensure that the ferrules used with the stainless steel needle are P/N 00101-18116. These Kel-F ferrules are 0.012-in. ID and are intended to be used only with the stainless steel needle. The Kel-F ferrules (P/N 00101-18114) that are supplied with your Accessory Kit are 0.008-in. ID and should not be used with the stainless steel needle.

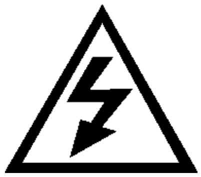


   a. Insert a (clear) Kel-F ferrule (P/N 00101-18206), wide end first, into a (brown) PEEK adapter union (P/N 00101-18206).
   b. Insert a stainless steel needle (P/N 00950-00954) through the ferrule and PEEK adapter union.

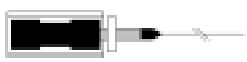
   c. Slide a second (clear) Kel-F ferrule, wide end first, over the stainless steel needle and into the free end of the PEEK adapter union.
   d. Use your finger to carefully push the stainless steel needle forward until it is flush with the tapered end of the Kel-F ferrule.



   e. Attach a (black) LC union (P/N 00101-18202) to the end of the PEEK adapter union, then tighten the LC union.
   f. Screw a (clear) 10-32 × 1/4-28 Kel-F fitting adapter into the ESI probe sample inlet.
   g. Carefully insert the stainless steel needle assembly through the ESI sample inlet and screw the (brown) PEEK adapter union into the 10-32 × 1/4-28 Kel-F fitting adapter.
   h. Hold the spray nozzle and carefully feed the stainless steel needle through the spray needle. Take care not to bend the stainless steel needle. Slide the spray nozzle forward and screw it into the ESI manifold. With a 5/16-in. wrench, gently tighten the spray nozzle until it is a little more than finger-tight. Do not overtighten the spray nozzle. The stainless steel needle will protrude 1 to 2 mm from the spray needle.



**CAUTION. AVOID ELECTRICAL SHOCK.** When you are operating your instrument in the ESI mode, you could receive an electrical shock unless you install the safety insulator discussed below. When you are using the optional Metal Needle Kit (P/N 70005-62013), you might receive an electrical shock if you touch the (black) LC union. Therefore, for your safety and in compliance with international safety standards, you **must** cover the LC union with the Metal Needle Safety Insulator (P/N 70001-20637) before you operate the instrument. Installation instructions (P/N 70001-97090) are included in the kit. Operation of the instrument without the safety sleeve impairs the safety protection provided by the instrument and, thus, could lead to serious injury.



i. Slide the Metal Needle Safety Insulator (P/N 70001-20637) over the LC union.

7. Install the fused-silica capillary tube and PEEK safety sleeve, as follows:

   a. Use a fused-silica cutting tool to cut a 25.4 cm (10.0 in.) piece of 0.1 mm ID × 0.19 mm OD fused-silica capillary (P/N 00106-10499). Ensure that you cut squarely the ends of the fused-silica tubing.

   b. Feed the sample tube through the precut 25.4 cm (10.0 in.), 009-in. ID × 0.240-in. OD PEEK safety sleeve (P/N 00301-22806). Ensure that the ends are flush to each other.

   c. Slide a (red) Fingertight fitting (P/N 00101-18195) and a (brown) ferrule (P/N 00101-18119), wide end first, onto the PEEK safety sleeve.

   d. Connect the PEEK safety sleeve and ferrule to the (black) LC union by tightening the (red) Fingertight fitting. Ensure that the Fingertight fitting is securely tightened around the PEEK safety sleeve, otherwise the sample stream might enter between the fused-silica capillary tube and the PEEK safety sleeve.

## Reinstalling the ESI Probe

To reinstall the ESI probe in the ESI flange, proceed as follows:

1. Ensure that the 2.0-in. ID spring-loaded Teflon O-ring (P/N 00107-18010), which seals the ESI probe to the ESI flange, is seated properly in the groove on the ESI flange.
2. Pass the sample tube and PEEK safety sleeve through the ESI flange and install the ESI probe into the ESI flange.
3. Pull the ESI probe back against the ESI flange. Tighten the probe retainer thumbscrew that holds the ESI probe to the ESI flange.

4. Slide a (brown) Fingertight fitting and a (brown) ferrule (P/N 00101-18119), wide end first, over the free end of the PEEK safety sleeve.
5. Connect the PEEK safety sleeve and ferrule to the (stainless steel) grounded fitting by tightening the (brown) Fingertight fitting. Ensure that the Fingertight fitting is securely tightened around the PEEK safety sleeve, otherwise the sample stream might enter between the sample tube and the PEEK safety sleeve.

## Reinstalling the ESI Probe Assembly

Reinstall the ESI probe assembly on the LCQDECA as described in the topic **Installing the ESI Probe Assembly** in the **Changing ESI or APCI Probe Assemblies** chapter, or place the ESI probe assembly in its storage container.

# Maintaining the APCI Probe

The APCI probe requires a minimum of maintenance. The APCI sample tube (150-µm ID fused-silica tubing) is preinstalled at the factory. However, if the sample tube becomes obstructed with salt precipitates or is broken, you need to replace it. Also, you might need to disassemble the APCI probe for cleaning or to replace a part.

Figure 4-3 shows the major components of the APCI probe. You do not need to vent the system to perform maintenance on the APCI probe.

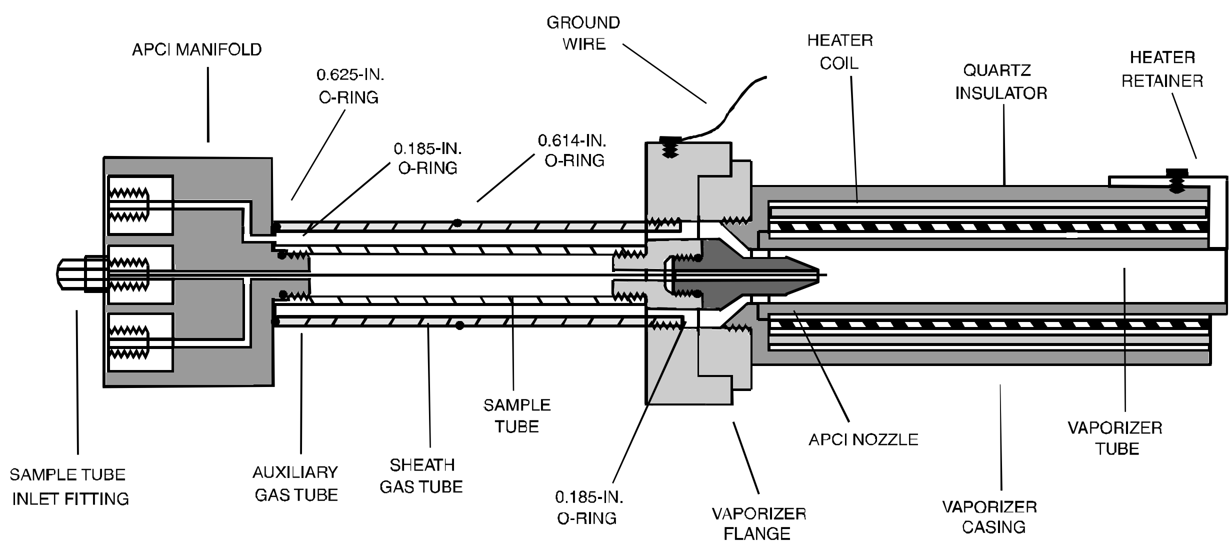



**Figure 4-3. Cross sectional view of the APCI probe**

**Note.** You should flush the APCI probe at the end of each working day by flowing a 50:50 methanol:water solution from the LC through the APCI source. Refer to the topic **Flushing the Sample Transfer Line, Sample Tube, and API Probe** on page 4-5.

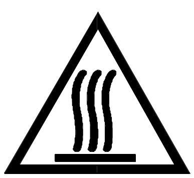
**Note.** Wear clean gloves when you handle APCI probe components.

The following procedures are discussed in this section:

- Removing the APCI probe assembly
- Disassembling the APCI probe assembly
- Cleaning the APCI probe components
- Removing the APCI sample tube
- Installing the APCI sample tube
- Reassembling the APCI probe assembly
- Reinstalling the APCI probe assembly

## Removing the APCI Probe Assembly

Remove the APCI probe assembly from the LCQDECA as described in the topic **Removing the APCI Probe Assembly** in the **Changing ESI or APCI Probe Assemblies** chapter.



**CAUTION. AVOID BURNS.** The APCI vaporizer heater can reach temperatures of 800 °C. Always allow the APCI probe to cool to ambient temperatures before handling or removing the APCI probe from the APCI flange.

**Caution.** Wrench flats on the APCI probe components are provided for your convenience when you dismantle the APCI probe. **NEVER USE THE WRENCH FLATS TO TIGHTEN THE APCI PROBE COMPONENTS.** Only tighten the APCI probe components by hand.

## Disassembling the APCI Probe Assembly

To disassemble the APCI probe assembly, proceed as follows:

1. Remove the corona discharge needle (P/N 70005-98033) by pulling it free from the corona discharge needle assembly. Store the needle by inserting it into one of the foam walls of the APCI probe assembly storage container.

> **Caution. Do not break the APCI sample tube.** In step 2a, carefully pull the APCI manifold straight back from the APCI probe to prevent the sample tube from touching the sides. If the sample tube hits the sides of the sheath gas tube, it can break.

2. Remove the APCI probe from the APCI flange, as follows:
   a. Hold onto the APCI flange with one hand and unscrew and remove the APCI manifold from the APCI probe. The sample tube remains with the APCI manifold.
   b. Loosen the probe retainer bolt that holds the APCI probe in the APCI flange.
   c. Remove the APCI probe from the interior of the APCI flange by gently pushing the probe from the outside of the flange. Do not disconnect the heater wires.
3. Remove the heater coil and quartz insulator, as follows:
   a. With an Allen wrench, remove the socket-head screw that secures the heater retainer to the vaporizer casing.
   b. Remove the heater coil and quartz insulator from the vaporizer.
4. With a Phillips screwdriver, disconnect the green electrical ground wire from the vaporizer flange.

If you want to clean the APCI probe components, go on to the next topic: **Cleaning the APCI Probe Components**.

If you want to replace the APCI sample tube only, go to the topic **Removing the APCI Sample Tube**.

## Cleaning the APCI Probe Components

To clean the APCI probe components, proceed as follows:

1. Complete the disassembly of the APCI probe as follows. See Figure 4-3 on page 4-20 for the location of the components.
   a. Unscrew and remove the vaporizer casing from the vaporizer manifold.
   b. Unscrew and remove the APCI nozzle from the vaporizer manifold.
   c. Unscrew and remove the auxiliary gas tube from the vaporizer manifold.
   d. Unscrew and remove the sheath gas tube from the vaporizer manifold.
2. Remove and check the condition of the 0.185-in. ID O-ring (P/N 00107-02585) on the APCI nozzle and the 0.614-in. ID O-ring (P/N 00107-05700) and 0.625-in. ID O-ring (P/N 00107-09015) on the auxiliary gas tube. Replace the O-rings if necessary.
3. Clean the APCI components with a 50:50 solution of methanol:distilled water and a lint-free swab. Dry the components with nitrogen gas and place them on a lint free tissue.
4. Reinstall the 0.614-in. and 0.625-in. O-rings on the auxiliary gas tube and the 0.185-in. O-ring on the APCI nozzle.
5. Reinstall the sheath gas tube (P/N 70005-20200) by gently screwing it by hand into the vaporizer manifold.
6. Reinstall the auxiliary gas tube (P/N 70005-20199) by gently screwing it by hand into the vaporizer manifold.
7. Reinstall the APCI nozzle (P/N 70005-20196) by gently screwing it by hand into the vaporizer manifold.
8. Reinstall the vaporizer casing (P/N 70005-20217) by gently screwing it by hand into the vaporizer manifold.

If you do not want to replace the APCI sample tube, go to the topic **Reassembling the APCI Probe Assembly**.

If you want to replace the APCI sample tube, go on to the next topic: **Removing the APCI Sample Tube**.

## Removing the APCI Sample Tube

To remove the APCI sample tube from the APCI manifold, proceed as follows:

1. With a 3/8-in. open-end wrench, remove the sample tube inlet fitting (P/N 70005-20250), 0.239-in. ID O-ring (P/N 00107-04000), and sample tube from the APCI manifold. Discard the old sample tube. See Figure 4-4.
2. Remove the exit-end nut (P/N 70005-20220), 0.016-in. ID, PEEK ferrule (P/N 00101-18120), and sample tube from the sample tube inlet fitting.

## Installing the APCI Sample Tube

To install a new APCI sample tube, proceed as follows:

1. Use a fused-silica cutting tool to cut a piece of 150 µm ID, 390 µm OD fused-silica tubing (P/N 00106-10498) to a length of approximately 15 cm (6 in.). Ensure that you squarely cut the ends of the fused-silica tubing.
2. Slide the exit-end nut (P/N 70005-20220) and ferrule (P/N 00101-18120) onto the length of the fused-silica tubing. See Figure 4-4.
3. Check the condition of the 0.239-in. ID O-ring (P/N 00107-04000) on the sample tube inlet fitting. Replace it if necessary.
4. Insert the fused-silica tubing into the sample tube inlet fitting.
5. Slide the exit-end nut and ferrule down the fused-silica tubing and into the sample tube inlet fitting.
6. Tighten the exit-end nut to secure the new sample tube (fused-silica tubing).
7. Gently slide the sample tube through the sample inlet of the APCI manifold. With a 3/8-in. open-end wrench, tighten down the sample tube inlet fitting to secure the fitting and compress the O-ring.
8. Unscrew and remove the vaporizer casing from the vaporizer flange (to expose the nozzle).
9. Gently slide the sample tube through the sheath gas tube of the APCI probe and out the APCI nozzle. Watch for the sample tube to exit the APCI nozzle. Screw the APCI manifold into the APCI probe (sheath gas tube).
10. Use a fused-silica cutting tool to cut the exit end of the sample tube so that approximately 1 mm protrudes past the tip of the APCI nozzle. See Figure 4-5.

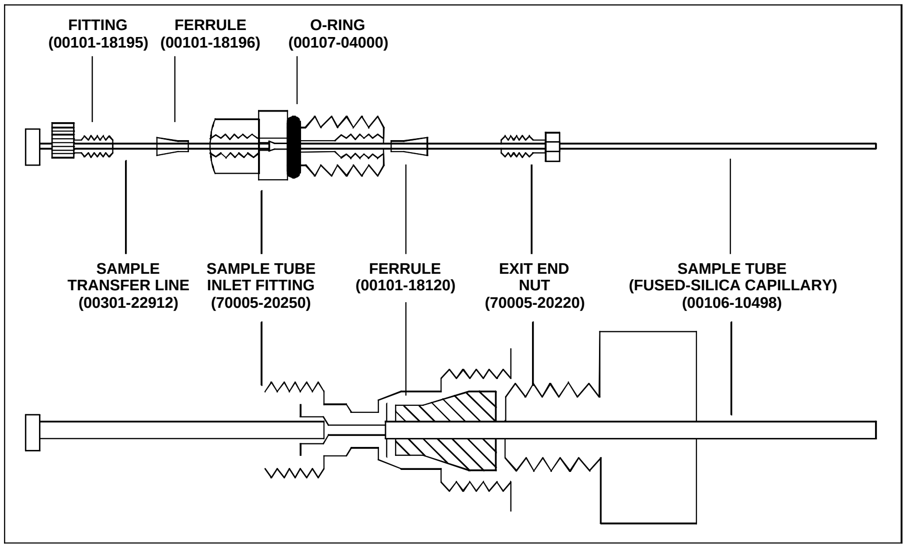



**Figure 4-4. APCI sample tube**

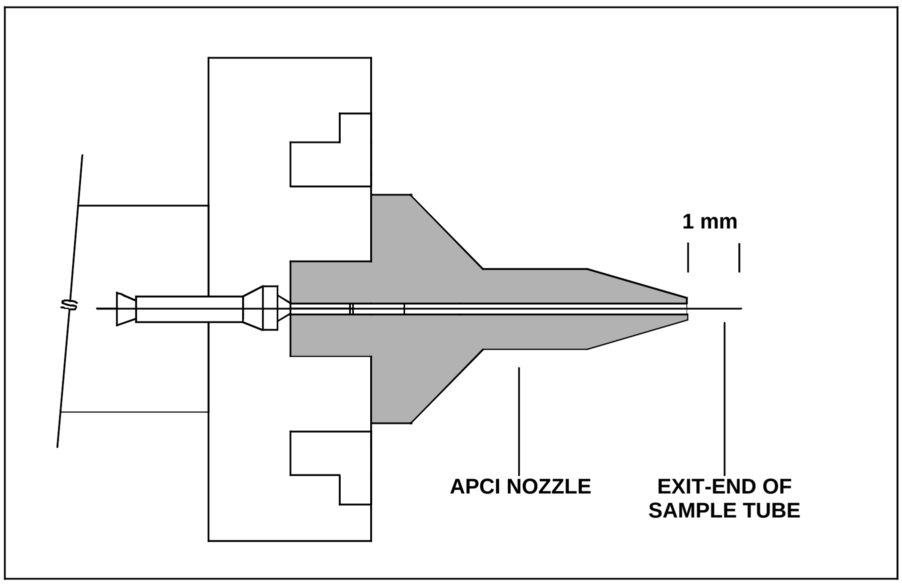



**Figure 4-5. Proper position of the exit end of the APCI sample tube**

> **Note.** Once the APCI sample tube has been cut to the proper length, you can remove the APCI manifold and accurately measure and record how far the sample tube extends past the end of the APCI manifold. The length should be about 6.5 cm (2.5 in.). In the future, sample tube replacement does not require complete disassembly of the APCI probe; just install the fused silica tubing in the APCI manifold and cut it to the proper length.

## Reassembling the APCI Probe Assembly

To reassemble the APCI probe assembly, proceed as follows:

1. Unscrew and remove the APCI manifold from the APCI probe. Be careful not to damage the sample tube.
2. Gently screw the vaporizer casing back into the vaporizer flange.
3. Reinstall the heater coil and quartz insulator into the vaporizer casing.
4. Use a Phillips screwdriver to reattach the electrical ground wire to the vaporizer flange. Make sure that the flat side of the connector is against the vaporizer flange.
5. Reinstall the heater retainer and secure it with the socket-head screw.
6. Reinstall the APCI probe (minus the APCI manifold) into the APCI flange.
7. Carefully slide the sample tube through the APCI flange, through the sheath gas tube, and out the APCI nozzle.
8. With one hand holding the vaporizer casing to keep the probe from turning, screw the APCI manifold onto the APCI probe.
9. Rotate the APCI probe until the half-moon of the heater retainer is oriented away from the tip of the corona discharge needle (when the corona discharge needle is installed). Tighten the probe retainer bolt to secure the APCI probe to the APCI flange. See Figure 4-6.
10. Move the ground wire away from the vaporizer casing.
11. Reinstall the corona discharge needle by inserting it into the socket in the corona discharge needle assembly.

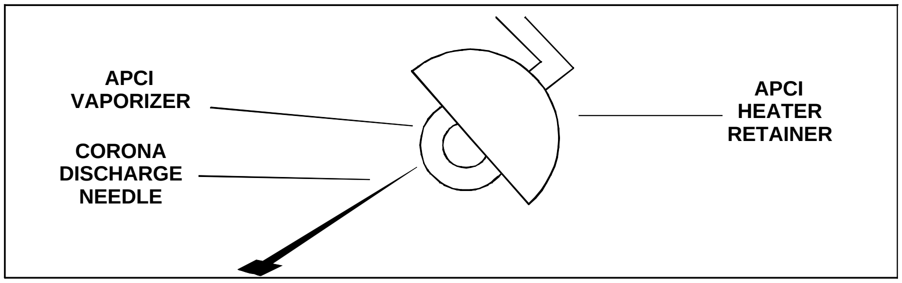



**Figure 4-6. Correct position of the APCI retainer cap to corona discharge needle**

## Reinstalling the APCI Probe Assembly

To reinstall the APCI probe assembly onto the LCQDECA, follow the procedure described in the topic **Installing the APCI Probe Assembly** in the **Changing ESI or APCI Probe Assemblies** chapter, or place the APCI probe assembly in its storage container.

# Maintaining the API Stack

The API stack includes the spray shield, heated capillary, tube lens, and skimmer. The heated capillary has a finite lifetime. You need to replace the heated capillary if the heated capillary bore becomes corroded or if the heater fails. You also need to clean the spray shield, heated capillary, tube lens, skimmer, and other components of the API stack on a periodic basis.

To replace the heated capillary or to clean the spray shield, heated capillary, tube lens, and skimmer, do the following:

- Shut down and vent the system
- Remove the API stack
- Disassemble the API stack
- Clean the API stack components
- Reassemble the API stack
- Reinstall the API stack
- Start up the system

**Note.** You should flush the spray shield and the bore of the heated capillary at the end of each working day with a 50:50 methanol:water solution. Refer to the topic **Cleaning the Spray Shield and the Heated Capillary** on page 4-6.

## Shutting Down the System

Shut down and vent the system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter.

## Removing the API Stack

To remove the API stack, proceed as follows. See Figure 4-7.

1. Loosen the two flange retainer bolts that secure the API flange to the spray shield.
2. Pull back the API probe assembly from the spray shield.
3. Disconnect the waste line from the spray shield.
4. Disconnect the API stack electrical cable from the spray shield by turning the tab on the end of the cable counterclockwise (toward you) and then pulling the cable free.
5. Grasp the spray shield with both hands and carefully pull it and the API stack free from the vacuum manifold. Place the API stack on a clean surface with the spray shield down. Allow the API stack to cool to ambient temperature before you disassemble the API stack.

**Note.** If you are unable to dislodge the spray shield from the vacuum manifold, reattach the API flange to the spray shield and then pull the flange away from the vacuum manifold.

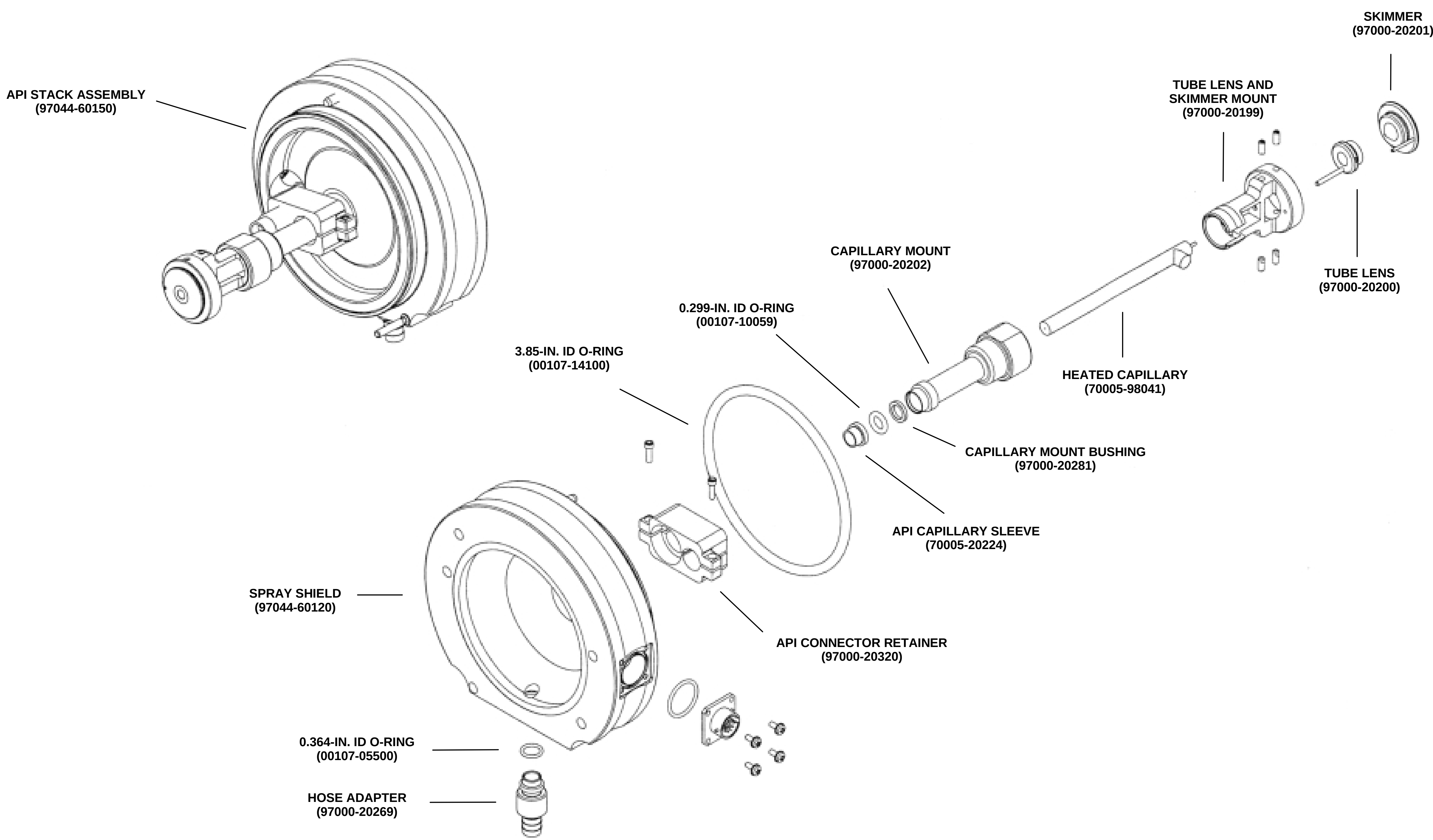



**Figure 4-7. API stack exploded view**

## Disassembling the API Stack

Wait for the API stack to cool to ambient temperature before you disassemble it. See Figure 4-7 for the location of the various API stack components. To disassemble the API stack, proceed as follows:

> **Note.** Wear clean, lint-free, nylon or cotton gloves when you handle the API stack components.

1. Disconnect the skimmer electrical lead from the lead pin on the skimmer.
2. Disconnect the tube lens electrical lead from the lead pin on the tube lens.
3. Pull the tube lens and skimmer mount free from the heated capillary mount.
4. Detach the skimmer from the tube lens and skimmer mount by pushing on its lead pin.
5. Detach the tube lens from the tube lens and skimmer mount by pushing the tube lens away from the skimmer mount.
6. Unscrew the locking ring on the heated capillary cable. Then, disconnect the heated capillary cable from the connector on the connector retainer.
7. Loosen the heated capillary mount from the spray shield by turning it counterclockwise. (Use a wrench if necessary.)
8. Remove the heated capillary, heated capillary sleeve, heated capillary mount, 0.299-in. ID O-ring, and bushing by pushing the heated capillary out of the spray shield from the atmospheric pressure side.
9. Pull the heated capillary sleeve and 0.299-in. ID O-ring off the end of the heated capillary.
10. Pull the heated capillary out of the heated capillary mount.

# Cleaning the API Stack Components

Inspect the API stack components for contamination that results from routine use. If dirty, clean the API stack components as described in the following topics:

- Cleaning the tube lens
- Cleaning the skimmer
- Cleaning the heated capillary
- Cleaning the spray shield

> **Note. Solvents required for cleaning the API stack components:** For most cleaning applications, HPLC grade methanol is the solvent of choice. However, the use of buffers or salt solutions during LC/MS operation might require that you use an acidic, aqueous cleaning solution. If you need to use a solvent other than methanol, after cleaning the ion source components, flush the component with water and then flush it with methanol as a final wash. In all cases, ensure that all solvent has evaporated from the component(s) before reassembly.

## *Cleaning the Tube Lens*

Clean the inner bore of the tube lens with HPLC-grade methanol and a cotton-tipped applicator (swab).

## *Cleaning the Skimmer*

Look at the tip of the cone on the skimmer for a region that shows discoloration due to contamination. (The off-axis pattern that you see is a result of the sample/solvent that exits from the off-axis heated capillary.) Use methanol and a cotton-tipped applicator or Kimwipe to clean the entrance and exit sides of the skimmer.

## *Cleaning the Heated Capillary*

To clean the heated capillary, proceed as follows:

1. Use methanol and a Kimwipe to clean the entrance end, exit end, and exterior of the heated capillary.
2. Clear the bore of the heated capillary by inserting and withdrawing the 28-gauge, 10-in. hypodermic tube (P/N 00106-20000) included in your accessory kit.

3. Flush the bore of the heated capillary with methanol.
4. Dry the bore of the heated capillary with nitrogen gas.

### *Cleaning the Spray Shield*

To clean the spray shield, wipe the inside and outside of the spray shield with methanol and a Kimwipe.

## Reassembling the API Stack

To reassemble the API stack, proceed as follows. Figure 4-7 for the location of the API stack components.

1. Wipe the heated capillary sleeve and the 0.299-in. ID O-ring with a lint-free tissue. Ensure that the heated capillary sleeve (P/N 70005-20224) and the 0.299-in. ID O-ring (P/N 00107-10059) are in good condition. Replace them if necessary.
2. Seat the heated capillary mount bushing in the end of the heated capillary mount.
3. Insert the heated capillary (P/N 97000-98002) though the heated capillary mount and heated capillary mount bushing.
4. Place the 0.299-in. ID O-ring and the heated capillary sleeve over the end of the heated capillary so that the heated capillary protrudes by approximately 2.5 cm (1 in.) past the end of the heated capillary sleeve.
5. Insert the heated capillary, heated capillary mount, heated capillary mount bushing, O-ring, and heated capillary sleeve through the connector retainer and into the spray shield until the heated capillary and heated capillary sleeve protrude from the atmospheric pressure side of the spray shield. Make sure that the heated capillary cable is on the same side as the connector on the connector retainer.
6. Screw the heated capillary mount into the spray shield by hand until it is tight. (The heated capillary mount bushing should seat in the end of the heated capillary mount and apply a force that compresses the 0.299-in. ID O-ring against the heated capillary sleeve.)
7. Reconnect the heated capillary cable to the connector that is held by the connector retainer. Turn the locking ring on the cable clockwise to lock the cable.
8. Insert the tube lens and skimmer mount over the heated capillary until it seats in the heated capillary mount. The tube lens and skimmer mount should be aligned such that the heated capillary cable comes out of the opening in the side of the tube lens and skimmer mount.
9. Align the guide pin on the tube lens with the guide pin hole on the tube lens and skimmer mount. Reinstall the tube lens by inserting it into the tube lens and skimmer mount.

10. Align the lead pin on the skimmer with the lead pin hole on the tube lens and skimmer mount. Reinstall the skimmer by inserting it into the tube lens and skimmer mount.
11. Reconnect the tube lens lead to the lead pin on the tube lens. Use needlenose pliers if necessary.
12. Reconnect the skimmer lead to the lead pin on the skimmer. Use needlenose pliers if necessary.
13. Push the heated capillary from the atmospheric pressure side of the spray shield until the opposite end of the heated capillary abuts with the tube lens and skimmer mount.

> **Note.** Ensure that the heated capillary abuts with the tube lens and skimmer mount. The API source will not operate properly unless the exit end of the heated capillary is at the proper distance from the skimmer.

14. Inspect the API stack. Ensure that the 3.85-in. ID O-ring (P/N 00107-14100) is in good condition and is properly seated on the spray shield. Ensure that all components fit together tightly. See Figure 4-7.

## Reinstalling the API Stack

To reinstall the API stack, proceed as follows:

1. Align the API stack with the opening in the front of the vacuum manifold. Turn the API stack until the guide pin on the spray shield is aligned with the guide pin hole in the vacuum manifold.
2. Carefully insert the API stack into the opening in the vacuum manifold until it seats in the vacuum manifold.
3. Reconnect the API stack cable to the connector on the spray shield. Turn the tab on the end of the cable clockwise (away from you) to secure the cable.
4. Reconnect the waste line to the spray shield.

# Starting Up the System

Start up the system as described in the topic **Starting Up the System After a Complete Shutdown** in the **System Shutdown, Startup, and Reset** chapter.

# 4.4 Purging the Oil in the Rotary-Vane Pumps

You need to purge (ballast) the oil in the rotary-vane pumps on a daily basis to remove water and other dissolved chemicals from the pump oil. Water and other chemicals in the rotary-vane pumps can cause corrosion and decrease the lifetime of the pumps. A good time to purge the oil is at the end of the working day after you flush the API probe, spray shield, and heated capillary.

To purge the oil in the rotary-vane pumps, proceed as follows:

1. Turn off the flow of sample solution from the LC to the MS detector.
2. Place the MS detector in Standby condition.
3. Withdraw the API flange from the spray shield and place a septum over the entrance to the heated capillary.
4. Open the ballast valve on the rotary-vane pumps by turning it to position **|**. Refer to the manual that came with the pump for the location of the ballast valve.
5. Allow the pump to run for 2 hours with the gas ballast valve open.
6. After 2 hours, close the gas ballast valve by turning it to position **O**.

## 4.5 Cleaning the Fan Filter

You need to clean the fan filter, located on the rear of the MS detector, every four months. To clean the fan filter, proceed as follows:

1. Remove the fan filter by reaching behind the MS detector and pulling the fan filter out to the right.
2. Wash the fan filter in a solution of soap and water.
3. Rinse the fan filter with tap water.
4. Squeeze the water from the fan filter and allow it to air dry.
5. When the fan filter is completely dry, reinstall it on the rear of the MS detector [or replace it with a new one (P/N 97000-20299)].

# Chapter 5
# Service Maintenance

This chapter describes MS detector maintenance procedures. It is your responsibility to maintain your system properly. However, the procedures in this chapter are perhaps best performed by a ThermoQuest Customer Support Engineer.

MS detector maintenance procedures are listed in Table 5-1.

**Table 5-1. Service maintenance procedures**

| MS Detector Component | Procedure | Frequency | Procedure Location |
|---|---|---|---|
| Ion optics | Clean quadrupole, octapole, and interoctapole lens | As needed* | Page 5-5 |
| Trap entrance lens | Clean trap entrance lens | As needed* | Page 5-5 |
| Mass analyzer | Clean mass analyzer | Yearly (or as needed*) | Page 5-5 |
| Ion detection system | Clean ion detection system (electron multiplier and conversion dynode) | Whenever the top cover plate of the vacuum manifold is removed | Page 5-15 |
| Ion detection system | Replace electron multiplier anode and cathode | If noise in spectrum is excessive or proper electron multiplier gain can not be achieved | Page 5-22 |
| Fuses | Replace fuse | If fuse has blown | Page 5-30 |
| PCBs | Replace PCB | If PCB fails | Page 5-35 |
| Ion gauge | Replace ion gauge | If ion gauge fails | Page 5-43 |
| Turbomolecular pump | Change oil reservoir | At least once a year | Page 5-59 |
| Turbomolecular pump | Replace turbomolecular pump | If turbomolecular pump fails | Page 5-59 |

*Frequency depends on analytical conditions

For instructions on maintaining LCs or autosamplers, refer to the manual that comes with the LC or autosampler.

The topics included in this chapter are as follows:

- Tools and supplies
- Frequency of cleaning
- Cleaning the ion optics and mass analyzer
- Replacing the electron multiplier
- Diagnostics
- Replacing a fuse
- Replacing PCBs and Assemblies
- Replacing the oil reservoir in the turbomolecular pump

**Note.** The keys to success with the procedures in this chapter are:

- Proceed methodically
- Always wear clean, lint-free gloves when handling the components of the ion optics, mass analyzer, and ion detection system
- Always place the components on a clean, lint-free surface
- Always cover the opening in the top of the vacuum manifold with a large, lint-free tissue whenever you remove the top cover plate of the vacuum manifold
- Never overtighten a screw or use excessive force
- Never insert a test probe (for example, an oscilloscope probe) into the sockets of female cable connectors on PCBs

## 5.1 Tools and Supplies

The LCQDECA requires very few tools for you to perform maintenance procedures. You can remove and disassemble many of the components by hand. The tools, equipment, and chemicals listed in Table 5-2 are needed for the maintenance of the ion optics, mass analyzer, and ion detection system.

**Table 5-2. Tools, equipment, and chemicals**

| Description | Part Number |
|---|---|
| Wrench, 5/16-in., hex socket (Allen) | |
| Wrench, 9/16-in., socket | |
| Wrench, 7/16-in., open end | |
| Wrench, 9/16-in., open end | |
| Wrench, 5/16-in., open end | |
| Wrench, 1/2-in., open end | |
| Wrench, 3/8-in., open end | |
| Screwdrivers, set, ball point, Allen (also referred to as ball drivers) | 00025-03025 |
| Screwdriver, slot head, large | |
| Screwdriver, slot head, small | |
| Screwdriver, Phillips, small | |
| Fused-silica cutting tool | |
| Hypodermic tube | 00106-20000 |
| Spray bottle | |
| Beaker, 450 mL | |
| Gloves, nylon | 00301-09700 |
| Kimwipes® or other lint-free industrial tissue | |
| Applicators (swabs), cotton-tipped | 00301-02000 |
| Detergent | |
| Clean, dry, compressed nitrogen gas | |
| Distilled water | |
| Methanol, HPLC grade or better | |

## 5.2 Frequency of Cleaning

**CAUTION.** As with all chemicals, solvents and reagents should be stored and handled according to standard safety procedures and should be disposed of according to local and federal regulations.

The frequency of cleaning the components of the MS detector depends on the types and amounts of samples and solvents that are introduced into the instrument. In general, for a given sample and ionization technique, the closer an MS detector component is to the source of the ions, the more rapidly it becomes dirty.

- The ion optics and the mass analyzer become dirty at a rate significantly slower than the API source. Refer to the topic **Cleaning the Ion Optics and Mass Analyzer** on page 5-5.
- Clean the electron multiplier and conversion dynode whenever you remove the top plate of the vacuum manifold by blowing them with a clean, dry gas. Refer to the topic **Cleaning the Ion Detection System** on page 5-15.

When the performance of your system decreases significantly because of contamination, clean the components of the MS detector in the following order:

- Clean the API probe, spray shield, and heated capillary
- Clean the tube lens and skimmer
- Clean the ion optics and mass analyzer

# 5.3 Cleaning the Ion Optics and Mass Analyzer

An accumulation of chemicals on the surfaces of the ion optics and mass analyzer forms an insulating layer that can modify the electrical fields that control ion transmission and mass analysis. Therefore, clean ion optics and mass analyzer are essential for the proper operation of the instrument. The ion optics and mass analyzer require cleaning less often than the API source. The frequency of cleaning depends on the type and quantity of the compounds that you analyze.

Cleaning the ion optics and mass analyzer involves the following steps:

- Shutting down the system
- Removing the top cover of the MS detector
- Removing the top cover plate of the vacuum manifold
- Removing the ion optics and mass analyzer
- Disassembling the ion optics and mass analyzer
- Cleaning the ion optics and mass analyzer parts
- Reassembling the ion optics and mass analyzer
- Reinstalling the ion optics and mass analyzer
- Cleaning the ion detection system
- Reinstalling the top cover plate of the vacuum manifold
- Reinstalling the top cover of the MS detector
- Starting up the system
- Tuning the ring electrode and quadrupole/octapole RF voltages

## Shutting Down the System

Shut down and vent the system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter.

## Removing the Top Cover of the MS Detector

Remove the top cover of the MS detector, as follows:

1. Disconnect any tubing between the syringe pump and the API source.
2. Open the left and right front doors of the MS detector by loosening the 1/4-in. Allen screw on the right front door with an Allen wrench.
3. Open the two fasteners that hold the top cover to the MS detector chassis. The fasteners are located in the upper right and left corners of the chassis.
4. With one hand under the center of the top cover, lift the top cover up and away from the MS detector.

## Removing the Top Cover Plate of the Vacuum Manifold

You need to remove the top cover plate of the vacuum manifold to access the ion optics, mass analyzer, and ion detection system. The top cover plate is held in place by gravity and by the air pressure differential between the vacuum manifold and atmospheric pressure. Six cables and one gas line are connected to the top cover plate.

To remove the top cover plate, proceed as follows. See Figure 5-1.

1. Disconnect (at ANAL. AUX 1 IN) the octapoles cable that comes from the Analyzer Auxiliary PCB.
2. Disconnect (at ANALYZER) the lenses cable that comes from the System Control PCB.
3. Disconnect (at ANAL. AUX 2 IN and ANAL. AUX 3 IN) the two endcap electrode cables that come from the Analyzer Auxiliary PCB.
4. Disconnect (at ACQU/DSP) the electrometer cable. (If necessary, use a small screw driver to loosen the screws that secure the cable.)
5. Disconnect (at MULT) the electron multiplier high voltage cable that comes from the electron multiplier power supply.
6. Use a 7/16-in. open-end wrench to disconnect the helium damping gas line from the fitting.
7. Carefully lift the top cover plate straight up by its two handles. Take care not to damage the components on the underside of the cover plate. Place the cover plate upside down (supported on its handles) on a flat surface.
8. Cover the opening in the top of the vacuum manifold with a large, lint-free tissue.

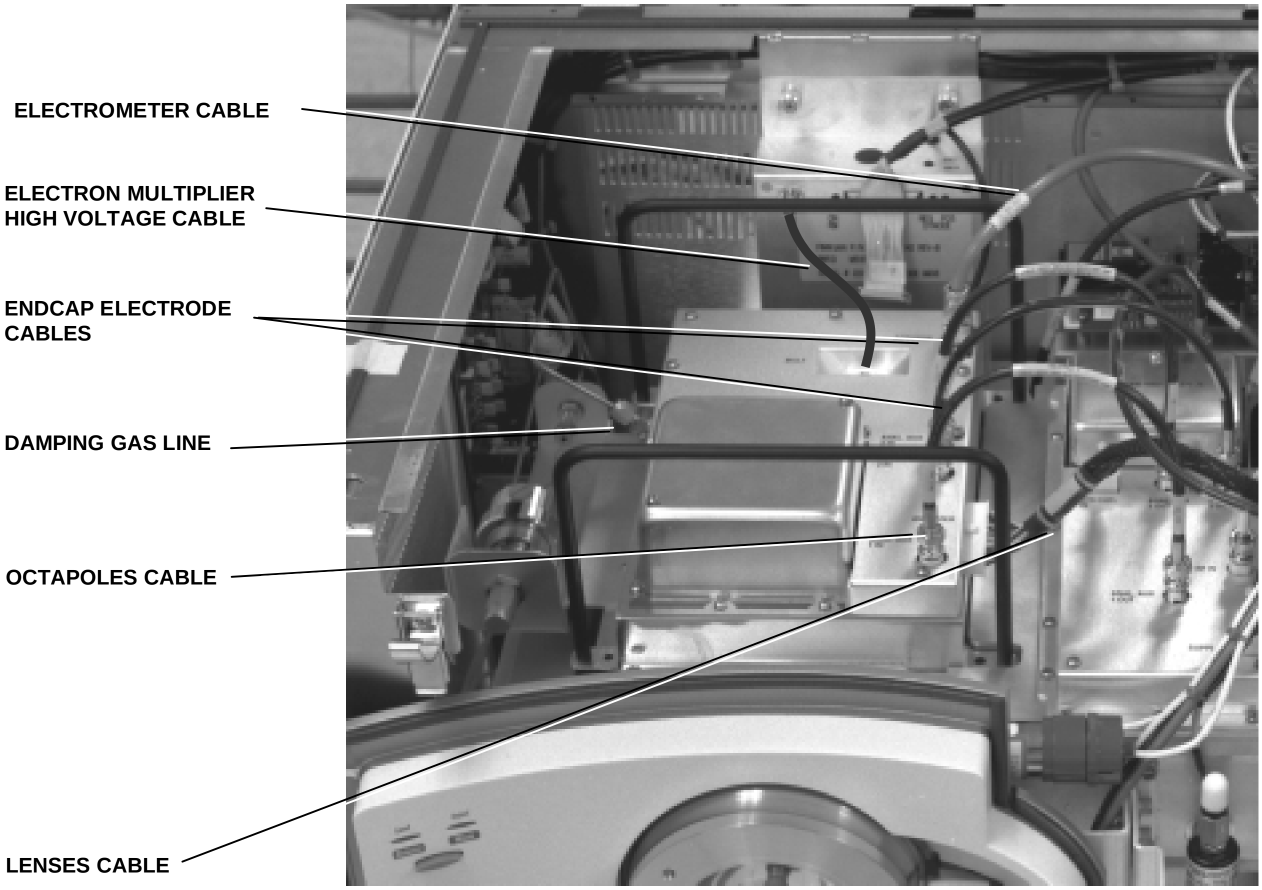



**Figure 5-1. Electrical connections and damping gas line connection to the top cover plate of the vacuum manifold**

## Removing the Ion Optics and Mass Analyzer

The ion optics and mass analyzer are mounted on a baffle on the underside of the top cover plate of the vacuum manifold.

Use the following procedure to remove the ion optics and mass analyzer from the top cover plate. See Figure 5-2 for the location of the ion optics and mass analyzer components.

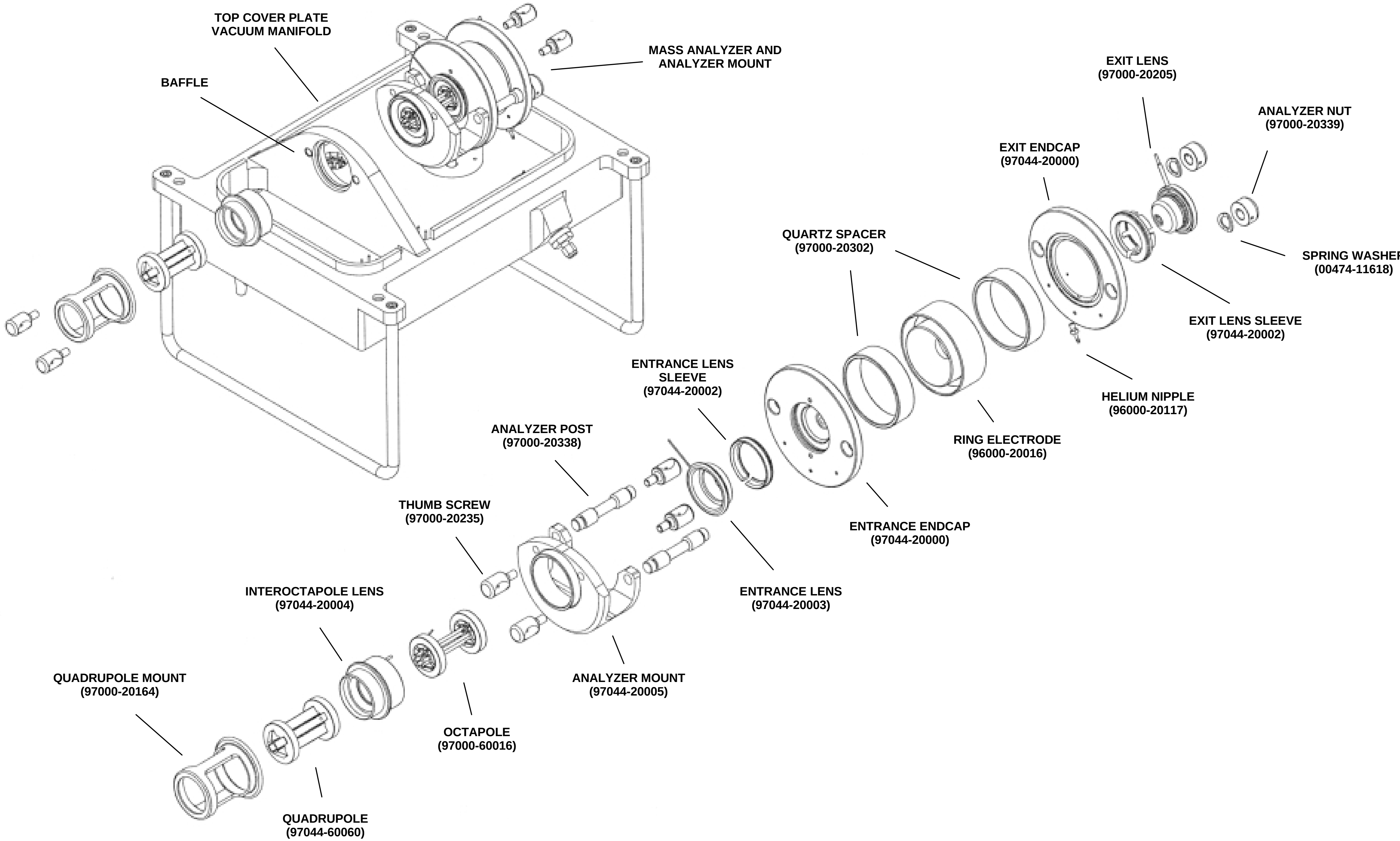



**Figure 5-2. Mass analyzer and ion optics exploded view**

> **Note.** Wear clean, lint-free, nylon or cotton gloves when you handle the ion optics and mass analyzer components.

1. Prepare a clean work area by covering the area with lint-free paper. Place each part on the paper as you remove it.
2. Disconnect the four electrical leads to the quadrupole.
3. Hold the quadrupole mount with one hand; loosen and remove the two thumb screws that hold the quadrupole mount to the baffle on the top cover plate of the vacuum manifold.
4. Remove the quadrupole and quadrupole mount.
5. Disconnect the electrical lead to the interoctapole lens. Remove the interoctapole lens.
6. Disconnect the electrical leads to the octapole and to the entrance lens, entrance endcap electrode, exit endcap electrode, and the exit lens of the mass analyzer.
7. Disconnect the damping gas line from the nipple on the exit endcap electrode by pulling the line free from the nipple. See Figure 5-2.
8. Hold the mass analyzer with one hand; loosen the two thumb screws that hold the analyzer mount to the baffle.
9. With one hand holding the mass analyzer and the other hand holding the analyzer mount, lift the mass analyzer, octapole, and analyzer mount out and away from the baffle on the top cover plate. Be careful not to touch the electron multiplier with the mass analyzer. This could damage the electropolished surface.

## Disassembling the Ion Optics and Mass Analyzer

To disassemble the ion optics and mass analyzer, proceed as follows. See Figure 5-2 for the location of the ion optics and mass analyzer components.

1. Remove the quadrupole from the quadrupole mount.
2. Remove the octapole from the analyzer mount.
3. Disassemble the mass analyzer, as follows:
    a. Remove the entrance lens by pulling the entrance lens out of the entrance lens sleeve.
    b. Remove the entrance lens sleeve by squeezing the sleeve and pulling it out of the recess in the entrance endcap electrode.
    c. Remove the exit lens by pulling the exit lens out of the exit lens sleeve. Use the connector pin to aid you pull off the lens.

d. Remove the exit lens sleeve by squeezing the sleeve and pulling it out of the recess in the exit endcap electrode.

e. Unscrew and remove the two analyzer nuts from the analyzer posts.

f. Remove the two spring washers from the analyzer posts.

g. Remove the exit endcap electrode from the analyzer posts.

h. Remove the two quartz spacer rings and the ring electrode.

i. Remove the entrance endcap electrode from the posts.

j. Unscrew and remove the two posts from the analyzer mount.

## Cleaning the Ion Optics and Mass Analyzer Parts

Use the following procedure to remove contamination from the ion optics and mass analyzer parts. Clean each part in turn. After cleaning, place each part on a clean, lint free surface.

> **Caution.** Take care not to chip, scratch, or break the spacer rings of the mass analyzer. Take care not to bump or jar the quadrupole and octapole. Do not place the quadrupole or octapole in an ultrasonic cleaner.

> **Note.** When you clean the ion optics and mass analyzer parts, pay particular attention to the inside surfaces.

1. With a soft tooth brush or lint-free swab, scrub the ion optics or mass analyzer part with a solution of detergent and water.
2. Rinse the part with tap water to remove the detergent.
3. Rinse the part with distilled water.
4. Place the part in a tall beaker and immerse it completely in HPLC-grade methanol. Move the part up and down in the methanol for 15 s.

> **Note.** Wear clean, lint-free, nylon or cotton gloves to handle the parts after you clean them in methanol.

5. Remove the part from the methanol bath, then rinse it thoroughly with fresh methanol.
6. Dry the part with a rapid stream of nitrogen gas.
7. Inspect each part for contamination and dust. If necessary, repeat the cleaning procedure.

## Reassembling the Ion Optics and Mass Analyzer

Use the following procedure to reassemble the ion optics and mass analyzer. See Figure 5-2.

> **Note.** Wear clean, lint-free, nylon or cotton gloves when you handle components of the mass analyzer.

1. Reassemble the mass analyzer, as follows:
   a. Reinstall the analyzer posts by screwing them by hand into the analyzer mount. (Both ends are the same.)
   b. Reinstall the entrance endcap electrode onto the analyzer posts. (The entrance endcap electrode is the one **without** the damping gas nipple.) Ensure that the electrode is oriented such that the convex surface faces away from the analyzer mount. Also, the opening in which the pin on the end of the electrical lead inserts should be close to the top cover plate when the analyzer mount is installed on the top cover plate.

> **Caution.** Handle the quartz spacer rings carefully. Do not scrape the spacer rings against any metal surfaces. Metal deposits on the surfaces of the spacer rings might cause the RF voltage to arc across the spacer rings to the endcaps. Do not overtighten the mass analyzer nuts.

   c. Place a quartz spacer ring into the groove in the entrance endcap electrode.
   d. Reinstall the ring electrode onto the quartz spacer ring so that the spacer ring is held securely between the electrodes. The orientation of the ring electrode is unimportant.
   e. Reinstall the second quartz spacer ring into the groove in the ring electrode.

f. Reinstall the exit endcap electrode (the one with the damping gas nipple) on the analyzer posts such that the quartz spacer ring is held in place between the ring electrode and the exit endcap electrode. Make sure that the electrode is oriented such that the convex surface faces the spacer ring. Also, the damping gas nipple should point toward the top cover plate when the analyzer mount is installed on the top cover plate.

g. Inspect the mass analyzer assembly. Ensure that all the parts are aligned properly and that they all fit together snugly.

h. Reinstall the spring washers on the analyzer posts such that the convex side of the washer is toward the exit endcap electrode.

i. Reinstall the analyzer nuts onto the analyzer posts and tighten the nuts by hand until they are finger tight. Do not overtighten the nuts.

j. Squeeze the exit lens sleeve and insert it into the recess in the exit endcap electrode. See Figure 5-2 for the proper orientation of the exit lens sleeve.

k. Insert the exit lens into the exit lens sleeve such that the lead pin on the exit lens points in the same direction as the 8-pin feedthrough when the analyzer mount is installed on the top cover plate. Make sure that the exit lens lead pin does not contact the nut on the end of the mass analyzer post.

## Reinstalling the Ion Optics and Mass Analyzer

Use the following procedure to reinstall the ion optics and mass analyzer onto the top cover plate of the vacuum manifold:

**Note**. Wear clean, lint-free, nylon or cotton gloves when you handle components of the ion optics and mass analyzer.

1. Insert the cylindrical end of the analyzer mount (with the mass analyzer and octapole attached) into the opening in the baffle on the top cover plate of the vacuum manifold. Ensure that the open side of the analyzer mount is away from the top cover plate.
2. Secure the analyzer mount to the baffle with the two thumb screws.
3. Squeeze the entrance lens sleeve and insert it into the recess in the entrance endcap electrode. See Figure 5-2 for the proper orientation of the exit lens sleeve.
4. Insert the entrance lens into the entrance lens sleeve such that the lead pin on the entrance lens points in the same direction as the 8-pin feedthrough when the analyzer mount is installed on the top cover plate.

5. Insert the octapole through the cylindrical end of the analyzer mount until it seats in the entrance endcap electrode of the mass analyzer. Turn the octapole until the lead pins are on the same side as the 4-pin feedthrough (when the analyzer mount is mounted on the top cover plate).
6. Insert the interoctapole lens, lead pin first, through the opening in the baffle. Turn the interoctapole lens until the lead pin is on the same side as the 8-pin feedthrough. Ensure that the second octapole is held securely between the endcap electrode and the interoctapole lens. Also ensure that the lead pins on the octapole are on the same side as the 4-pin feedthrough.
7. Insert the quadrupole into the quadrupole mount.
8. Attach the quadrupole and quadrupole mount to the baffle on the top cover plate with the two thumb screws. Ensure that the interoctapole lens is held securely between the two multipoles.
9. Inspect the ion optics. Ensure that all the parts are aligned properly and that they all fit together snugly.
10. Reconnect the electrical lead from pin 8 of the 8-pin feedthrough to the entrance lens. See Figure 5-3.
11. Reconnect the four electrical leads from pins 1 through 4 of the 4-pin feedthrough to the quadrupole.
12. Reconnect the electrical lead from pin 2 of the 8-pin feedthrough to the interoctapole lens.
13. Reconnect the two electrical leads from pins 1 and 3 of the 4-pin feedthrough to the octapole. (It does not matter which lead is connected to a particular lead pin of the octapole.)
14. Reconnect the electrical lead from pin 4 of the 8-pin feedthrough to the entrance endcap electrode by inserting the pin on the end of the lead into the socket in the electrode.
15. Reconnect the electrical lead from pin 5 of the 8-pin feedthrough to the exit endcap electrode by inserting the pin on the end of the lead into the socket in the electrode.
16. Reconnect the electrical lead from pin 7 of the 8-pin feedthrough to the exit lens. Ensure that the exit lens lead pin does not contact the analyzer nut.
17. Reconnect the damping gas line to the nipple on the exit endcap electrode.

> **Note**. Check all leads and ensure that they are secure and that they go to the proper electrodes.

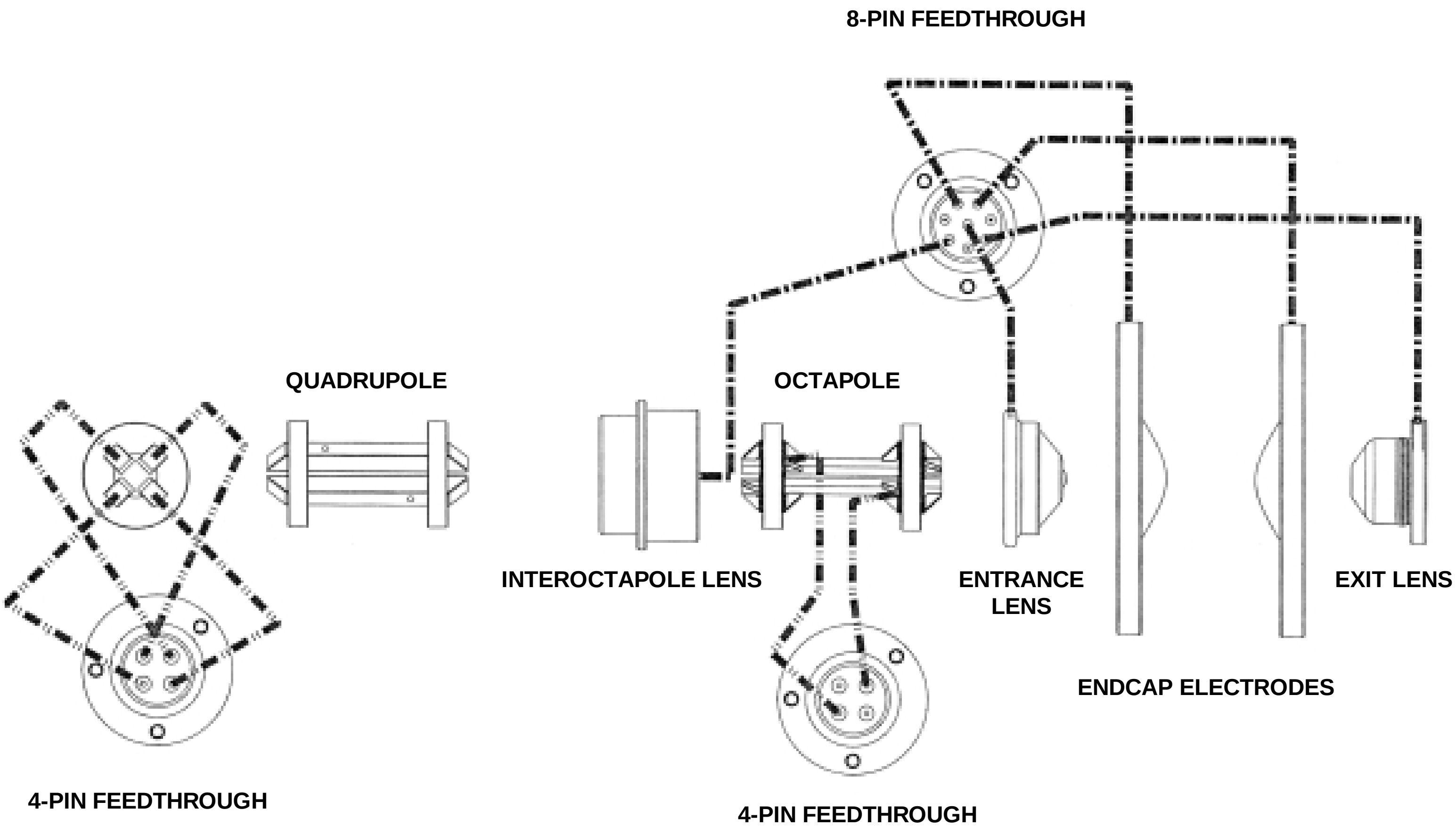



**Figure 5-3. Analyzer electrical connections**

## Cleaning the Ion Detection System

The conversion dynode and electron multiplier of the ion detection system must be kept dust free. Clean the conversion dynode and electron multiplier whenever you remove the top cover plate of the vacuum manifold. Cleaning the conversion dynode and electron multiplier involves only blowing them with clean, dry gas such as nitrogen. Freon gas is not recommended. **Do not use liquids to clean the ion detection system components.** Always cover the opening in the top of the vacuum manifold with a large, lint-free tissue whenever you remove the top cover plate of the vacuum manifold.

## Reinstalling the Top Cover Plate of the Vacuum Manifold

Use the following procedure to reinstall the top cover plate of the vacuum manifold:

1. Remove the tissue from the opening in the top of the vacuum manifold.
2. Check the O-ring that surrounds the opening for signs of wear, and replace it if necessary (P/N 97000-40015). Make sure that the O-ring is seated properly.

> **Note.** Periodically, remove any contamination that might be on the inner walls of the manifold by wiping the inner walls with a lint-free tissue soaked in HPLC-grade methanol. Use a cotton-tipped applicator soaked in methanol to clean around inlets and feedthroughs.

3. Carefully lift the top cover plate up by its two handles and turn it over. Orient the top cover plate such that the electron multiplier is over the conversion dynode. Carefully insert the guide posts on the underside of the top cover plate into the guide holes in the vacuum manifold. Slowly lower the cover plate onto the opening in the vacuum manifold. Take care not to damage the components on the underside of the cover plate. Ensure that the cover plate is seated properly on the vacuum manifold.
4. Use a 7/16-in. open-end wrench to reconnect the helium damping gas line to the fitting. See Figure 5-1.
5. Reconnect (at ANAL. AUX 1 IN) the octapoles cable that comes from the Analyzer Auxiliary PCB.
6. Reconnect (at ANALYZER) the lenses cable that comes from the System Control PCB.
7. Reconnect (at ANAL. AUX 2 IN and ANAL. AUX 3 IN) the two endcap electrode cables that come from the Analyzer Auxiliary PCB.

8. Reconnect (at ACQU/DSP) the electrometer cable.
9. Reconnect (at MULT) the electron multiplier high voltage cable that comes from the electron multiplier power supply.

## Reinstalling the Top Cover of the MS Detector

Reinstall the top cover of the MS detector, as follows:

1. Open the left and right front doors of the MS detector.
2. With one hand under the center of the top cover, place the top cover on the MS detector chassis. Slide the top cover forward until it is engages the four guides located at the rear of the chassis.
3. Lower the front of the top cover onto the chassis so that the two guide posts located on the front underside of the top cover enter the guide holes located on the top of the chassis.
4. Secure the top cover to the chassis with the two latches located on the front of the chassis.
5. Close the left and right front doors of the MS detector.
6. Reconnect any tubing between the syringe pump and the API source to accommodate your instrument configuration.

## Starting Up the System

Start up the system as described in the topic **Starting Up the System After a Complete Shutdown** in the **System Shutdown, Startup, and Reset** chapter.

## Tuning the Ring Electrode and Quadrupole/Octapole RF Voltages

You need to tune the ring electrode RF voltage and the quadrupole/octapole RF voltage whenever you service the mass analyzer or ion optics. You also need to tune these voltages if you replace any electronic assembly that is involved in producing the RF voltages. You use the Diagnostics program to tune the ring electrode and quadrupole/octapole RF voltages.

To tune the ring electrode and quadrupole/octapole RF voltages, proceed as follows:

1. Allow the LCQDECA to pump down for at least 15 min after start up.
2. Open the Diagnostics dialog box and Graph view, as follows:
   a. Open the Tune Plus window.
   b. In the Tune Plus window, open the Diagnostics dialog box.
   c. Select the **Graphs** tab. See Figure 5-4.
   d. Reposition the Diagnostics dialog box so that it does not obscure the Graph view.
3. Tune the quadrupole/octapole RF voltage, as follows:
   a. Select **Tune octapole frequency** in the Test Type text box.
   b. Select the **Once** option button in the How many times group box.
   c. Start the quadrupole/octapole RF voltage tune program. A frequency function appears in the Graph view. See Figure 5-5. The minimum of the frequency function should lie between 2400 and 2550 kHz.
   d. When the octapole tune program is finished, LCQDECA displays the message: Do you want to accept the octapole frequency? Select the **Yes** button.

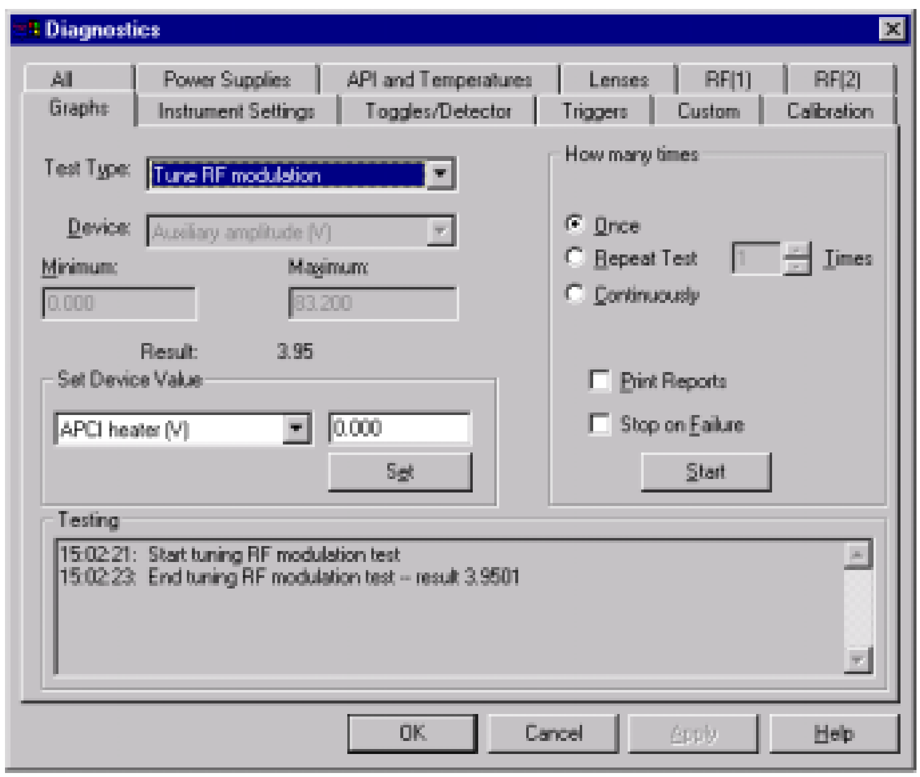



**Figure 5-4. Diagnostics dialog box (Graph page)**

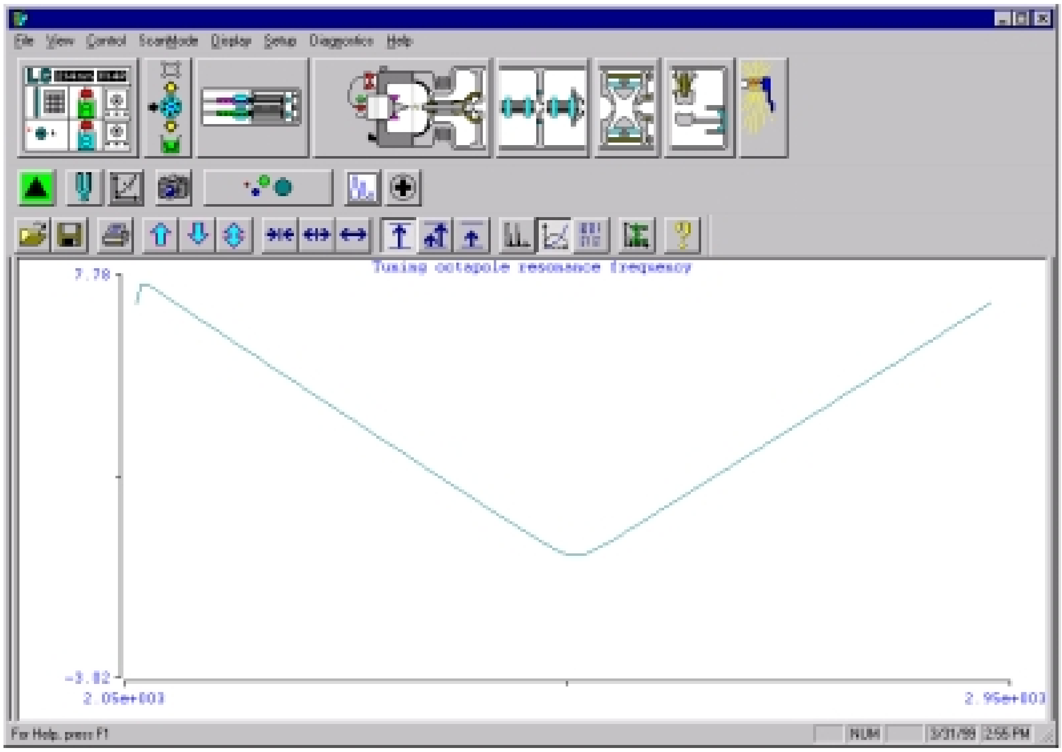



**Figure 5-5. Graph view for quadrupole/octapole RF voltage tuning**

4. Tune the ring electrode RF voltage modulation, as follows:

   a. Select **Tune RF modulation** in the Test Type text box.

   b. Select the **Once** option button in the How many times group box.

   c. Start the ring electrode RF modulation tune program. The Graph view should look like Figure 5-6:

      - The standing wave ratio switch line should be at 10 V over the entire range.
      - The detected RF voltage should be a straight line that begins at the origin and intersects the standing wave ratio switch line near the highest mass line.
      - The RF voltage modulation should be a curved line that begins at the origin and intersects the highest mass line at a value between 3.5 and 4.5 V.

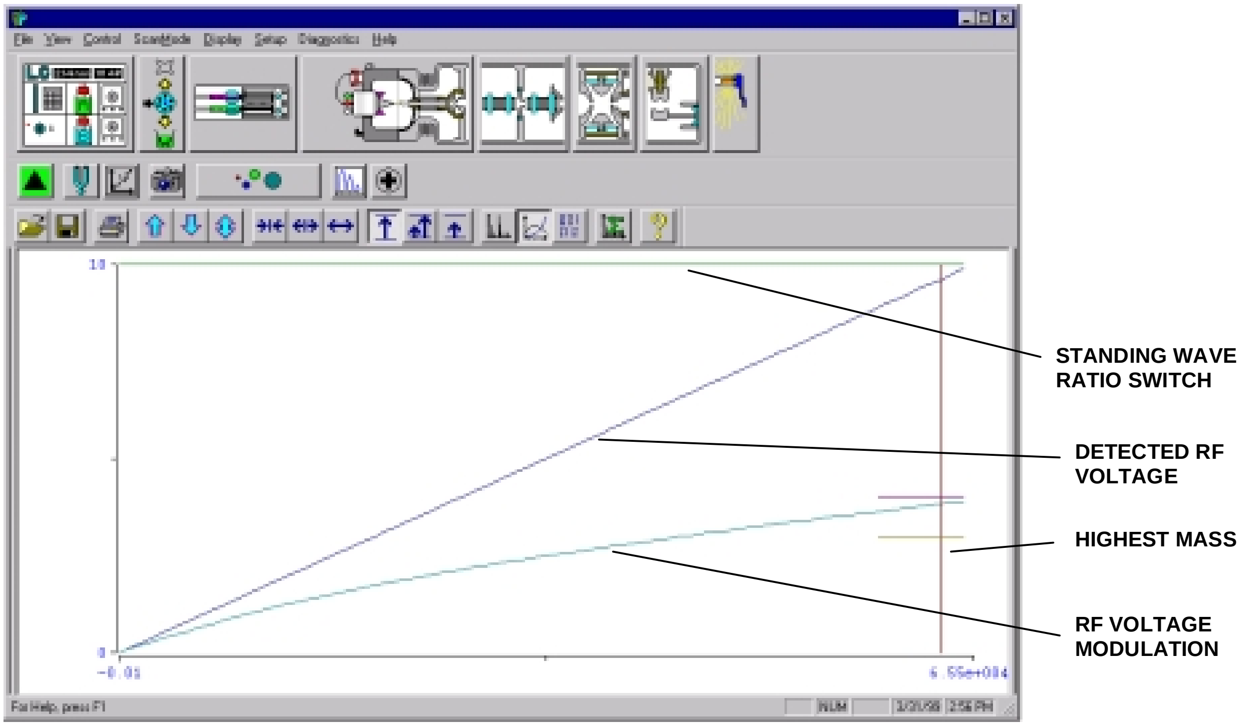



**Figure 5-6. Graph view for ring electrode RF voltage modulation tuning**

d. Inspect the Graph view:

- If the three above conditions are met, proceed to step 5.
- If the three above conditions are met over part of the range but not all of the range (the curves flatten or change value abruptly), tune the RF voltage frequency as described in step 5. Then, repeat step 4.
- If the standing wave ratio switch, detected RF voltage, and RF voltage modulation lines are all flat, then there might be a loose connection. Make sure that all cables and leads are properly connected and that the spring-loaded pin on the RF voltage feedthrough properly contacts the ring electrode. Repeat step 4.

5. Tune the ring electrode RF voltage frequency, as follows:

a. Select **Tune RF frequency** in the Test Type text box. The Continuously option button in the How many times group box is automatically selected.

b. Start the ring electrode RF frequency tune program. The Graph view displays several tune functions, a frequency cursor, and a frequency window. See Figure 5-7.

c. Allow the program to make at least five passes. Then determine whether the frequency cursor lies within the frequency window:

- If the frequency cursor lies within the frequency window, then the ring electrode RF voltage frequency is tuned properly. Select the **Stop** button and exit from the diagnostics program.
- If the frequency cursor lies outside the frequency window, then you need to manually adjust the ring electrode RF voltage frequency. Leave the Graph view displayed. Go on to the next step.

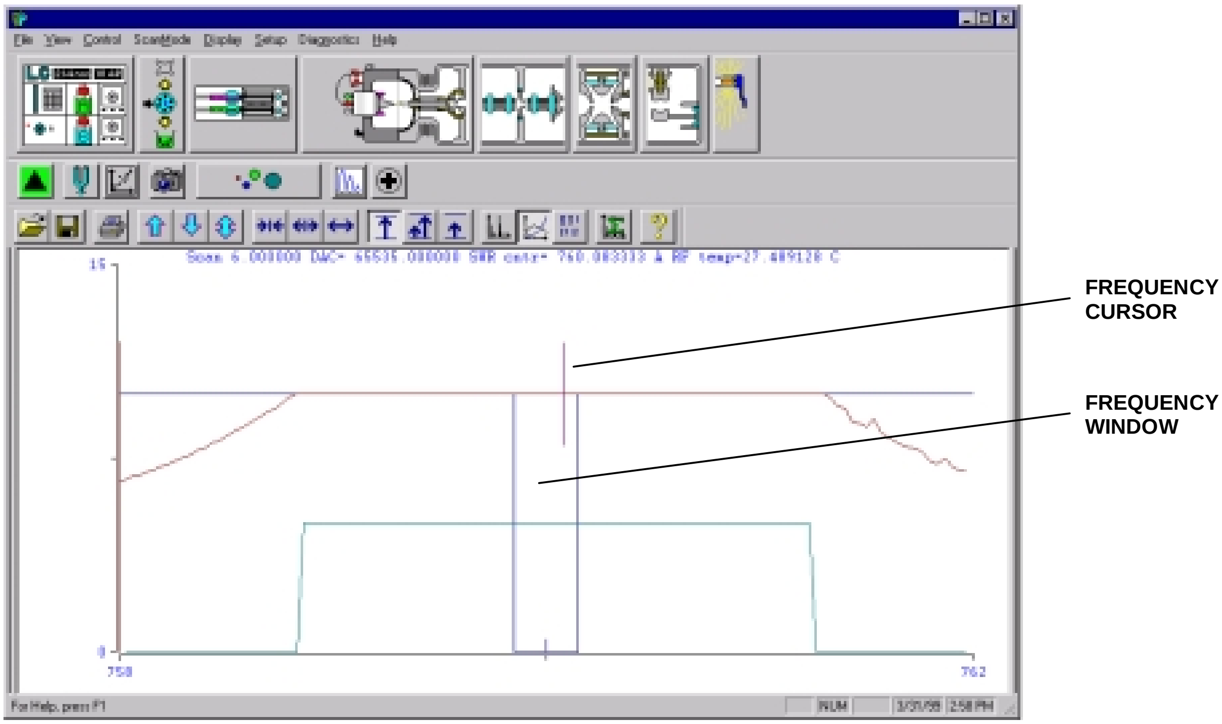



**Figure 5-7. Graph view for ring electrode RF voltage tuning**

6. Manually adjust the ring electrode RF voltage frequency, as follows:
   a. Open the left front door of the MS detector.
   b. With a Phillips screw driver, remove the air deflector to expose the tuning stud.
   c. With a wrench, loosen the 9/16-in. lock nut that holds the tuning stud in place. See Figure 5-8.
   d. With a screw driver, turn the tuning stud until the frequency cursor lies slightly to the left of the center of the frequency window. (The cursor should shift slightly to the right when the air deflector is reinstalled.)
   e. Tighten the 9/16-in. lock nut.

f. Reinstall the air deflector and close the left front door of the MS detector. Make sure that the frequency cursor is still within the frequency window. If necessary, repeat the above steps.

g. Select the **Stop** button to stop the ring electrode RF voltage frequency tune program.

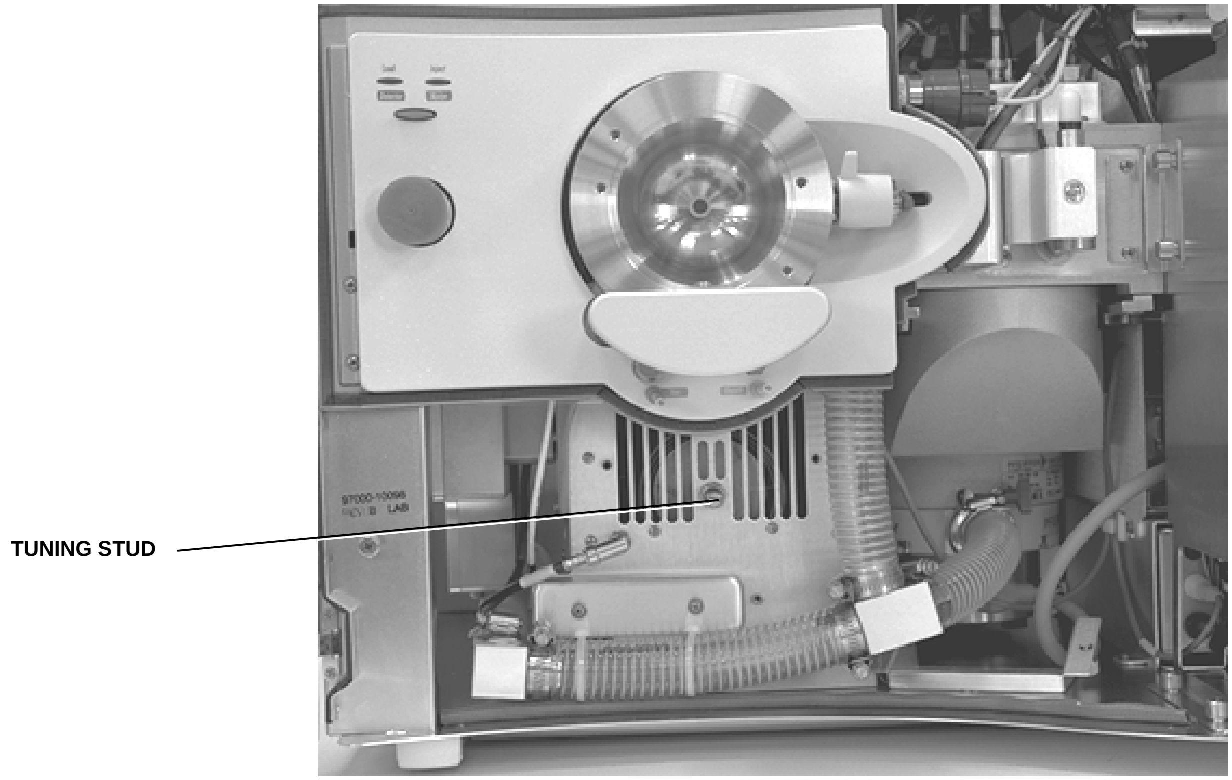



**Figure 5-8. Ring electrode RF voltage tuning stud (with air deflector removed)**

# 5.4 Replacing the Electron Multiplier

The electron multiplier of the ion detection system includes an anode and a cathode. See Figure 5-9. The anode and cathode have finite lifetimes. The anode loses sensitivity over time due to contamination of its surface. The lifetime of the cathode is decreased by: heat; electron flow (which produces internal heat); air (which causes oxidation and arcing); and water (which causes arcing).

The following symptoms suggest that the electron multiplier may need replacing:

- Excessive noise in the mass spectrum
- Inability of the multiplier gain calibration procedure to achieve a gain of $3 \times 10^5$ electrons per ion with an electron multiplier voltage less than or equal to 2.5 kV

You can read the current value of the electron multiplier voltage in the Ion Detection System dialog box, which can be reached from the Tune Plus window by clicking on the ion detection system button.

If you are having problems with the ion detection system, you need to replace the anode and cathode of the electron multiplier. You can replace the cathode separately or as part of the electron multiplier assembly.

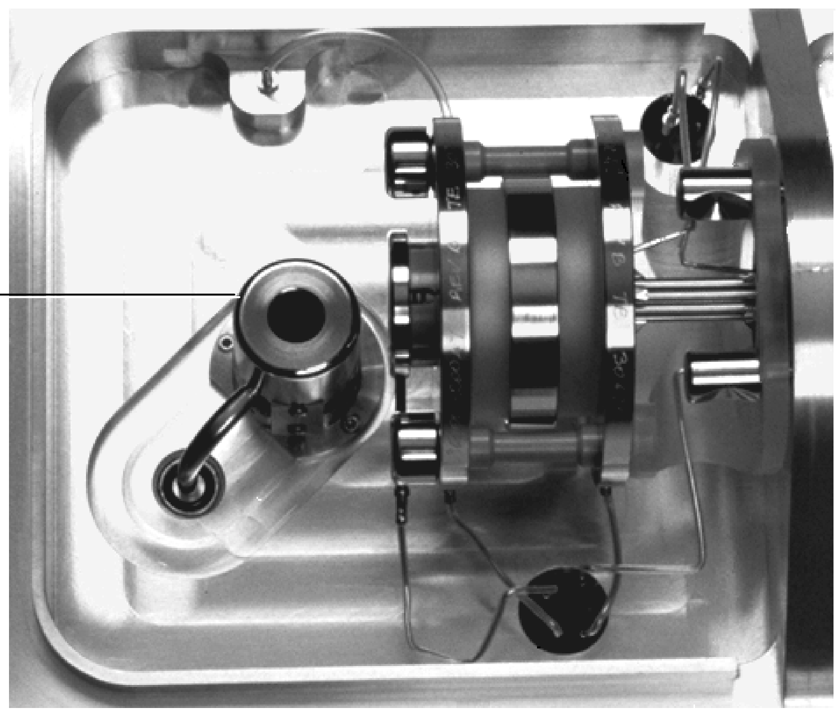



**Figure 5-9. Top cover plate of vacuum manifold showing electron multiplier**

To replace the anode and cathode of the electron multiplier, or the entire electron multiplier assembly, proceed as follows:

1. Shut down and vent the system as described in the topic **Shutting the System Down Completely** in the **System Shutdown, Startup, and Reset** chapter.
2. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** on page 5-6.
3. Remove the top cover plate of the vacuum manifold as described in the topic **Removing the Top Cover Plate of the Vacuum Manifold** on page 5-6.

> **Note.** Wear clean, lint-free, nylon or cotton gloves when you handle the electron multiplier components.

4. With an Allen wrench, remove the two socket-head screws that hold the electron multiplier support to the top cover plate of the vacuum manifold.
5. With one hand hold the high voltage tube and with the other hand hold the electron multiplier support. Then, detach the high voltage tube from the high voltage feedthrough in the top cover plate and remove the electron multiplier as a unit. (The anode remains in the anode feedthough in the top cover plate.) See Figure 5-10.
6. Remove the anode from the anode feedthrough by unscrewing it counterclockwise by hand.
7. Install a new anode (P/N 96000-20076) in the anode feedthrough in the top cover plate by screwing it clockwise by hand.

If you want to replace the entire electron multiplier, install a new electron multiplier (P/N 96000-60036) in the next step. If you want to replace only the cathode, install the old electron multiplier in the next step.

> **Caution.** Be careful not to damage the surface of the electron multiplier shield. The electron multiplier shield has been electropolished to prevent field emission.

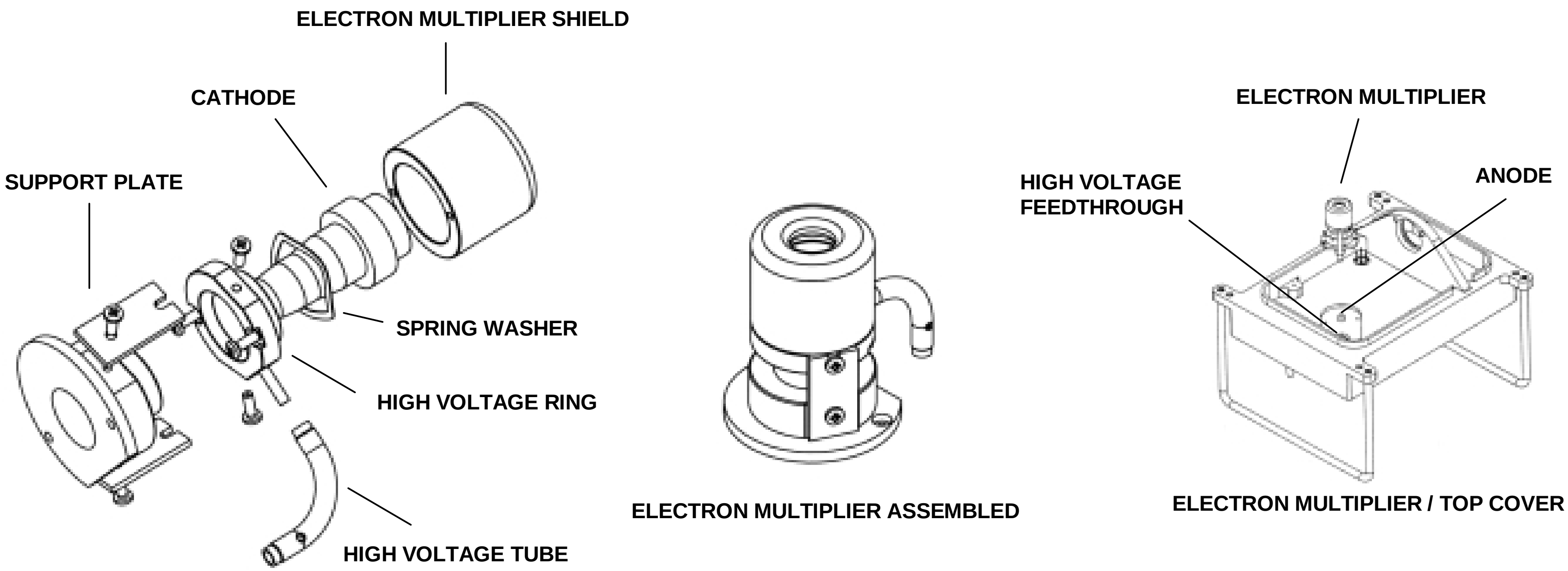



**Figure 5-10. Electron multiplier (exploded view, assembled view, top cover view)**

8. With one hand holding the high voltage tube and the other hand holding the electron multiplier support, install the electron multiplier on the top cover plate. Ensure that the high voltage tube is properly inserted in the high voltage feedthrough and that the screw holes in the electron multiplier support are aligned with the screw holes in the top cover plate.
9. Reinstall the two socket-head screws that secure the electron multiplier support to the top cover plate. Tighten the screws with an Allen wrench.
   - If you installed a new electron multiplier in step 8, go to step 11.
   - If you want to replace the cathode, go on to the next step.
10. To replace the cathode, proceed as follows. See Figure 5-10.
    a. With a Phillips screwdriver, loosen (but do not remove) the two screws that secure the support plates to the high voltage ring.
    b. With one hand, hold the high voltage tube. With the other hand, hold the high voltage ring. Then, detach the high voltage tube from the high voltage feedthrough and remove the electron multiplier. Place it on a clean surface. (The electron multiplier support and the support plates should remain attached to the top cover plate.)
    c. Turn the assembly over. With a Phillips screwdriver, remove the two screws that secure the electron multiplier shield to the high voltage ring.
    d. Remove the electron multiplier shield and cathode from the high voltage ring.
    e. Insert the narrow end of a new cathode (P/N 00022-02400) first through the spring washer and then through the high voltage ring.
    f. Place the electron multiplier shield over the wide end of the cathode such that the screw holes in the electron multiplier shield are aligned with the screw holes in the high voltage ring.
    g. Hold the high voltage ring and electron multiplier shield together to depress the spring washer. Secure the high voltage ring to the electron multiplier shield by using the two Phillips-head screws. (The cathode should be held in place between the high voltage ring and the electron multiplier shield.)
    h. Insert the end of the high voltage tube in the electron multiplier feedthrough in the top cover plate. Reattach the high voltage ring to the support plates by inserting the two screws in the sides of the high voltage ring into the notches in the two support plates. Tighten the two Phillips-head screws that secure the high voltage ring to the two support plates.
11. Reinstall the top cover plate of the vacuum manifold over the opening in the vacuum manifold as described in the topic **Reinstalling the Top Cover Plate of the Vacuum Manifold** on page 5-15.

12. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** on page 5-16.
13. Start up the LCQDECA system as described in the topic **Starting Up the System After a Complete Shutdown in the System Shutdown, Startup, and Reset** chapter.
14. Set the electron multiplier voltage to -800 V, as follows:
    a. From the Tune Plus window, choose **Diagnostics | Diagnostics**.
    b. Select the **Graphs** tab.
    c. In the Set Device Value option box, select **Multiplier (V)**.
    d. In the text box to the right of the Set Device Value option box, enter -800.
    e. Select the **Set** button to set the electron multiplier voltage to -800 V.
    f. Select the **OK** button to return to Tune Plus.
15. Calibrate the electron multiplier voltage, as follows:
    a. Allow the system to pump down for at least one hour before you turn on the high voltages.
    b. Set up for the infusion of the tuning solution into the MS.
    c. From the Tune Plus window, choose **Control | Calibrate**. The Calibrate dialog box appears.
    d. Select the **Semi-Automatic** tab.
    e. Select the Electron Multiplier Gain option. Select the **Start** button to start the multiplier gain procedure.
16. After the Electron Multiplier Gain program is finished, set up for ESI or APCI operation.

## 5.5 Diagnostics

Many of the MS detector components can be tested by the LCQDECA diagnostics. You should replace LCQDECA components when indicated by the LCQDECA diagnostics.

The LCQDECA diagnostics is used to test the major electronic circuits within the instrument and indicate whether the circuits pass or fail the tests. If there is a problem with the instrument electronics, the LCQDECA diagnostics can often locate the problem. You can then often correct the problem by replacing a faulty PCB or assembly.

The LCQDECA diagnostics does not diagnose problems that are not electrical in nature. For example, it does not diagnose poor sensitivity due to misaligned or dirty components or to improper tuning. Therefore, it is important to have someone who is familiar with system operation and basic hardware theory run the diagnostics and use it to assist in isolating any problems.

Before running the diagnostics, consider the following:

- Did the system fail when you were running samples?
- Did problems occur after you performed maintenance on the instrument, data system, or peripherals?
- Did you change the system's configuration, cables, or peripherals just before the problem occurred?

If the answer is yes to the first item above, there is the possibility of a hardware failure, and running the diagnostics is appropriate.

If the answer is yes to one of the last two items above, the problem is probably mechanical, not electrical. Verify that alignment, configurations, and cable connections are correct before you run the LCQDECA diagnostics.

To run the LCQDECA diagnostics, proceed as follows:

1. Tune the ring electrode and quadrupole/octapole RF voltages as described in the topic **Tuning the Ring Electrode and Quadrupole/Octapole RF Voltages** on page 5-16.
2. In the Tune Plus window, choose **Diagnostics | Diagnostics**. The Diagnostics dialog box appears. See Figure 5-11.
3. Select one of the following options. Refer to Table 5-3.
   - To test all of the electronic subsystems (that is, the vacuum system, power supplies, lenses, ion detection system, and RF voltage electronics), click on the **All** tab and select the **Everything** option.
   - To test an individual subsystem, click on the tab corresponding to that subsystem and select the appropriate options.
4. Select how many times you want to run the tests, and whether or not you want to print reports or to stop on a failure.
5. Select the **Start** button to start the diagnostics.

LCQDECA starts testing and displays a chronological log of all diagnostic tests in the Testing text box. Once testing for a specific subsystem is completed, LCQDECA displays either Pass or Fail in the Results group box. If the LCQDECA diagnostics indicates a problem, perform the maintenance procedure indicated by the LCQDECA diagnostics. For more information on the LCQDECA diagnostics, refer to the LCQDECA online Help.

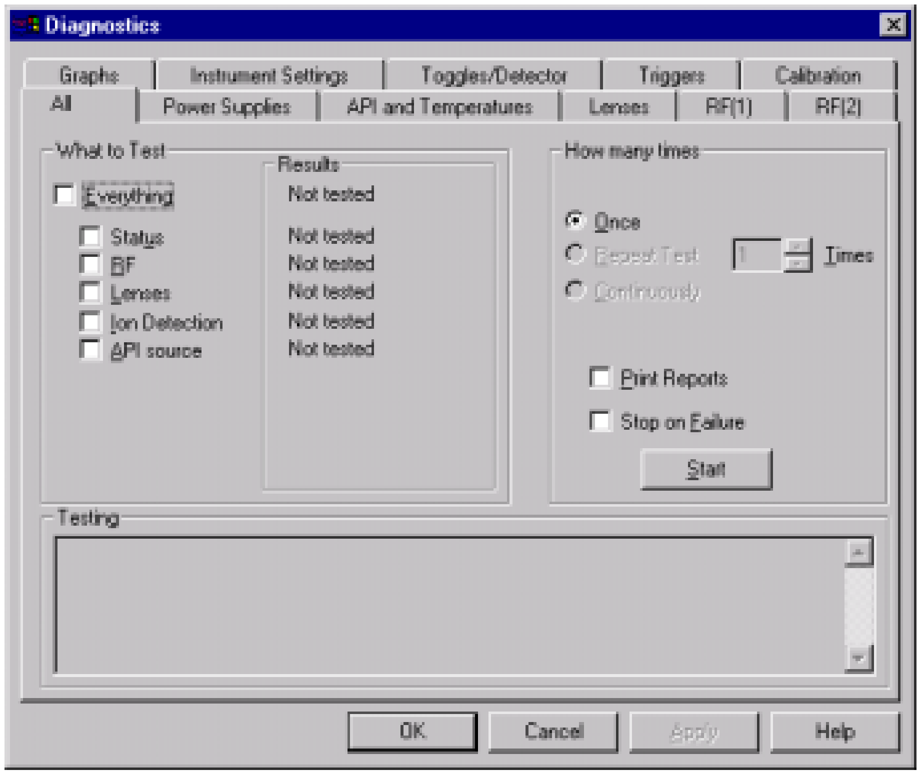



**Figure 5-11. Diagnostics dialog box (All page)**

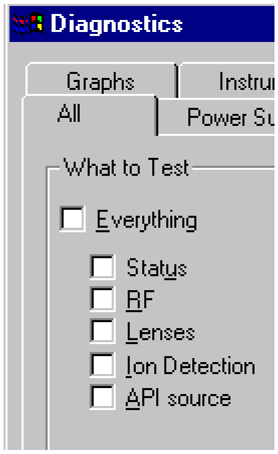
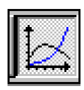



**Table 5-3. Diagnostic tests in Tune Plus**

| If you check (☑ ) | Diagnostics will |
|---|---|
| Everything | test Status, RF, Lenses, Ion Detection, and API source (5 min to complete) |
| Status | check all device static values, refer to Table 5-4 |
| RF | test five RF devices, refer to Table 5-4 |
| Lenses | test four LENSES devices, refer to Table 5-4 |
| Ion Detection | test three ION DETECTION devices, refer to Table 5-4 |
| API source | test three API source devices, refer to Table 5-4 |

**Table 5-4. Diagnostic items tested in Tune Plus**

| Item Tested in What to Test Group Box | Scanning Device Number in Graph View  | Scanning Device Name |
|---|---|---|
| Status | n/a | Refer to **Table A-1** in the **Appendix** for static details |
| RF-1 | 03 (readback number 06) | Aux amplitude (V) 0 to 83.2 |
| RF-2 | 10 | Main RF DAC (16-bit) 0 to 65535 |
| RF-3 | 11 (readback number 50) | Vernier det. RF amp (V) 0 to 65535 |
| RF-4 | 11 (readback number 51) | Vernier RF DAC (16-bit) 0 to 65535 |
| RF-5 | 25 (readback number 52) | Octapole RF DAC (V) 0 to 1000 |
| Lenses-1 | 30 | Octapole 1 offset (V) -132 to 132 |
| Lenses-2 | 01 | Octapole 2 offset (V) -132 to 132 |
| Lenses-3 | 07 | Octapole lens (V) -136 to 136 |
| Lenses-4 | 25 | Octapole det. RF amp. (V) 0 to 1000 |
| Ion Detection-1 | 04 | Trap Offset (V) -132 to 132 |
| Ion Detection-2 | 17 | Tube gate (V) -200 to 198 |
| Ion Detection-3 | 05 (readback number 41) | Multiplier (V) 0 to -2200 |
| API-1 | 20 | Auxiliary gas flow (arb) 0 to 60 |
| API-2 | 19 | Sheath gas flow (arb) 20 to 100 |
| API-3 | 23 | Capillary Voltage (V) -132 to 132 |

# 5.6 Replacing a Fuse

Fuses protect the various circuits by opening the circuits whenever overcurrent occurs. On the MS detector, most of the fuses are located on the System Control PCB. Several fuses, however, are located on the RF Voltage Amplifier PCB, Analyzer Auxiliary PCB, and Power Module. The function and current rating of the various fuses are listed in Table 5-5.

Check fuses when power is lost to a fused subsystem.

**CAUTION.** Always place the electronics service switch in the Service Position (or shut down the system and disconnect the power cord) before you replace fuses on the System Control PCB, RF Voltage Amplifier PCB, or Analyzer Auxiliary PCB.

**Table 5-5. MS detector fuses**

| Location | Fuse | Circuit | Description | P/N |
|---|---|---|---|---|
| System Control PCB | F1 | Multipoles and tube lens power supplies, ion gauge grid | 0.25 A, time lag, 5 x 20 mm, 250 V | 00006-01700 |
| System Control PCB | F2 | Multipoles and tube lens power supplies | 0.25 A, time lag, 5 x 20 mm, 250 V | 00006-01700 |
| System Control PCB | F3 | Heated capillary, multipoles, and mass analyzer DC offsets | 0.16 A, time lag, 5 x 20 mm, 250 V | 00006-01700 |
| System Control PCB | F4 | Heated capillary, multipoles, and mass analyzer DC offsets | 0.16 A, time lag, 5 x 20 mm, 250 V | 00006-01700 |
| System Control PCB | F5 | Ion gauge filament | 3.15 A, time lag, 5 x 20 mm, 250 V | 00006-10510 |
| System Control PCB | F6 | Heated capillary heater | 2.5 A, Type F, 5 x 20 mm, 250 V | 00006-11202 |
| System Control PCB | F7 | Conversion dynode power supply | 0.25 A, time lag, 5 x 20 mm, 250 V | 00006-11204 |
| System Control PCB | F8 | RF detector power supply | 0.4 A, time lag, 5 x 20 mm, 250 V | 00006-05080 |
| System Control PCB | F9 | RF detector power supply | 0.4 A, time lag, 5 x 20 mm, 250 V | 00006-05080 |
| System Control PCB | F10<br>F11 | APCI vaporizer heater | 2.5 A, time lag, 5 x 20 mm, 250 V | 00006-09510 |
| RF Voltage Amplifier PCB | F1 | +36 V | 1.0 A, quick act, 5 x 20 mm, 250 V | 00006-07610 |
| RF Voltage Amplifier PCB | F2 | -28 V | 0.5 A, quick act, 5 x 20 mm, 250 V | 00006-07608 |
| Analyzer Auxiliary PCB | F1 | -28 V | 1.6 A, quick act, 5 x 20 mm, 250 V | 00006-08610 |
| Analyzer Auxiliary PCB | F2 | +36 V | 1.6 A, quick act, 5 x 20 mm, 250 V | 00006-08610 |
| Power Module | F1 | Voltage select switch | 3.5 A, time lag, 5 x 20 mm, 250 V | 00006-10510 |

> **Caution.** Use only the fuses specified in Table 5-5. Never replace a fuse with a fuse of a different type, voltage, or current rating.

> **Note.** To replace the fuse in the Power Module you need to remove the tower, System Control PCB, and embedded computer. Do not replace the fuse in the Power Module unless you are qualified to do so.

To replace a fuse on the System Control PCB, RF Voltage Amplifier PCB, or Analyzer Auxiliary PCB, proceed as follows:

1. Place the electronics service switch in the Service Position (or shut down and vent the LCQDECA system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter).

> **CAUTION.** Make sure that the LCQDECA electronic service switch is in the Service Position (or shut down the system and disconnect the power cord) before you proceed.

2. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** on page 5-6.
   - To replace a fuse on the System Control PCB, go to step 3.
   - To replace a fuse on the RF Voltage Amplifier PCB, go to step 4.
   - To replace a fuse on the Analyzer Auxiliary PCB, go to step 5.
3. To replace a fuse on the System Control PCB, proceed as follows. See Figure 5-11 for the location of the System Control PCB and its fuses.
   a. Remove the right side cover of the MS detector, as follows:
      i. Loosen the fastener that secures the right side cover to the chassis of the MS detector.
      ii. Slide the side cover back about 1.25 cm (0.5 in.), and then pull it out and away from the MS detector.
   b. Remove the System Control PCB protective cover, as follows:
      i. With a Phillips screwdriver, loosen the five screws that hold the protective cover to the MS detector chassis.
      ii. Pull the cover up and out of the guide slots on the MS detector chassis.

**Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

c. Locate and replace the defective fuse on the System Control PCB with a fuse of the same type, voltage, and current rating. Refer to Table 5-5.

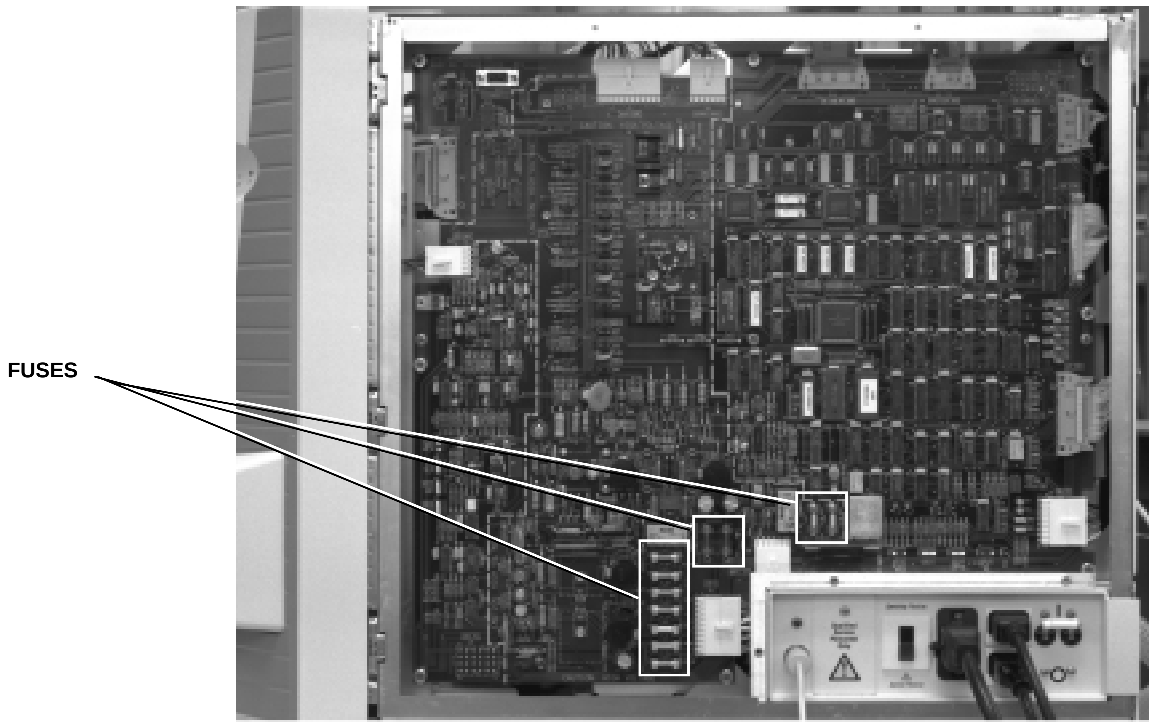



**Figure 5-12. System Control PCB, showing the location of the fuses**

d. Reinstall the protective cover over the System Control PCB, as follows:

    i. Insert the protective cover into the guide slots on the MS detector chassis and push the cover down until it is seated.

    ii. With a Phillips screwdriver, tighten the five screws that hold the protective cover to the MS detector chassis.

e. Reinstall the right side cover of the MS detector, as follows:

    i. Place the cover against the right side of the MS detector such that the studs on the cover insert into the guide slots on the System Control PCB protective cover.

    ii. Slide the side cover forward about 1.25 cm (0.5 in.) until the studs on the cover lock in the guide slots.

iii. Tighten by hand the fastener that secures the side cover to the chassis of the MS detector.

Go to step 6.

4. To replace a fuse on the RF Voltage Amplifier PCB, proceed as follows. See Figure 5-15 on page 5-44 for the location of the RF Voltage Amplifier PCB.

   a. With a Phillips screwdriver, loosen the eight screws that hold the metal cover to the RF Voltage Amplifier PCB. Remove the cover.

   b. Locate and replace the defective fuse on the RF Voltage Amplifier PCB with a fuse of the same type, voltage, and current rating. Refer to Table 5-5.

   c. Place the metal cover over the RF Voltage Amplifier PCB. With a Phillips screwdriver, tighten the eight screws that secure the cover.

   Go to step 6.

5. To replace a fuse on the Analyzer Auxiliary PCB, proceed as follows. See Figure 5-15 on page 5-44 for the location of the Analyzer Auxiliary PCB.

   a. Disconnect the seven cables that connect to the top of the Analyzer Auxiliary PCB. (Three coaxial cables come from the Analyzer PCB, one coaxial cable comes from the Waveform DDS PCB in the embedded computer, one coaxial cable comes from the Waveform Amplifier PCB, one 7-lead cable comes from the System Control PCB, and one 4-lead cable comes from the 36 V power supply.)

   b. With a Phillips screwdriver, loosen the six screws that hold the metal cover to the Analyzer Auxiliary PCB. Remove the protective cover to expose the Analyzer Auxiliary PCB.

   c. Locate and replace the defective fuse on the Analyzer Auxiliary PCB with a fuse of the same type, voltage, and current rating. Refer to Table 5-5.

   d. Reinstall the protective cover on the Analyzer Auxiliary PCB. With a Phillips screwdriver, tighten the six screws that hold the metal cover to the Analyzer Auxiliary PCB.

   e. Reconnect the seven cables that connect to the top of the Analyzer Auxiliary PCB. (Three coaxial cables come from the Analyzer PCB, one coaxial cable comes from the Waveform DDS PCB in the embedded computer, one coaxial cable comes from the Waveform Amplifier PCB, one 7-lead cable comes from the System Control PCB, and one 4-lead cable comes from the 36 V power supply.)

6. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** on page 5-16.

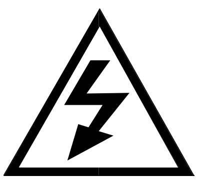
7. Place the electronics service switch in the Operating Position.

8. Run the LCQDECA diagnostics to verify that the system is operational.

## 5.7 Replacing PCBs and Assemblies

The following procedures are discussed in this topic:

- Replacing PCBs and assemblies in the tower
- Replacing PCBs in the embedded computer
- Replacing the Vent Delay PCB and backup battery, ion gauge, and vent valve
- Replacing the electron multiplier and Conversion Dynode Power Supplies, Analyzer PCB, Analyzer Auxiliary PCB, Waveform Amplifier PCB, RF Voltage Amplifier PCB
- Replacing the System Control PCB
- Replacing the RF Voltage Control PCB
- Replacing the Low Pass Filter PCB



**CAUTION.** With the electronics service switch in the Service Position, power is still supplied to the rotary-vane pump, Turbomolecular Pump Controller, turbomolecular pump, turbomolecular pump fan, +24 V keep alive power supply, vent valve, and Vent Delay PCB. Thus, before these components can be serviced, the main power circuit breaker switch must be placed in the Off (O) position and the power cord must be unplugged from the power outlet.

**Caution.** Never insert a test probe (for example, an oscilloscope probe) into the sockets of female cable connectors on PCBs. This can damage the sockets.

# Replacing PCBs and Assemblies in the Tower

The following PCBs and assemblies are installed in the tower. See Figure 5-13.

- +5 V, ±15 V, +24 V dc and +36 V, -28 V dc switching power supplies
- Turbomolecular Pump Controller
- 8 kV power supply
- Power Module

**Note.** To service the Power Module you need to remove the tower, System Control PCB, and embedded computer. Do not service the Power Module unless you are qualified to do so.

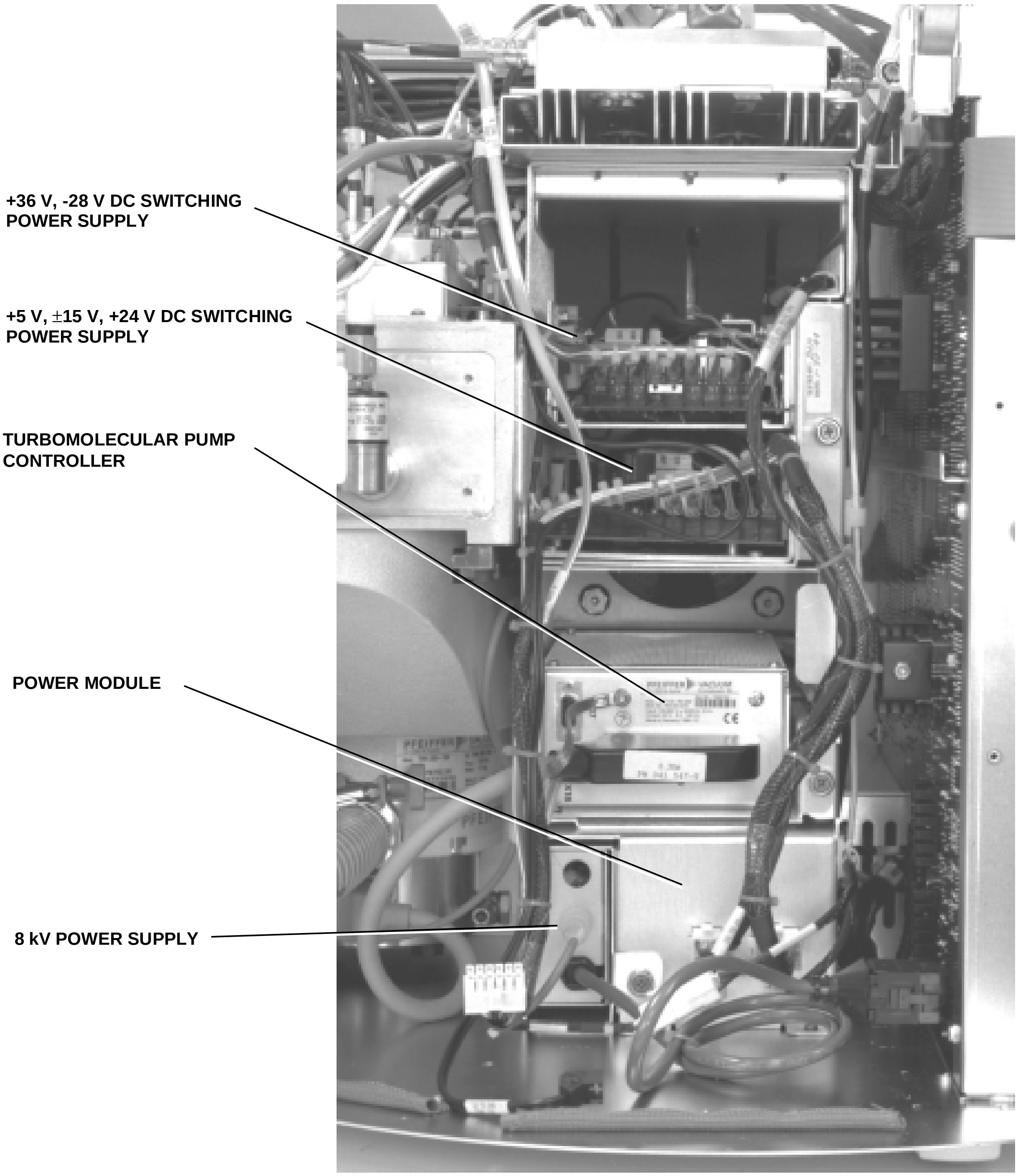



**Figure 5-13. Tower (embedded computer removed)**

To replace a component that is in the tower, proceed as follows:

1. Shut down and vent the system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter.

> **CAUTION.** Make sure that the LCQDECA power cord is unplugged before you proceed.

2. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** on page 5-6.
3. Reposition the embedded computer (to expose the tower), as follows:
   a. Disconnect the cables that connect to the top of the embedded computer.
   b. Loosen the six fasteners that secure the embedded computer to the vacuum manifold, base plate, and chassis.
   c. Lift up the embedded computer a sufficient distance to access the two cables that connect to the bottom of the embedded computer. Disconnect the two cables that connect to the bottom of the embedded computer.
   d. Lift the embedded computer and reposition it such that the two hooks in the back of the embedded computer box insert into the two slots in the MS detector chassis. See Figure 5-14 on page 5-42 for the location of the slots.
      - To replace the switching power supply assembly (which includes the +5 V, ±15 V, +24 V dc and +36 V, -28 V dc switching power supplies), go to step 4.
      - To replace the Turbomolecular Pump Controller, go to step 5.
      - To replace the 8 kV power supply, go to step 6.
4. To replace the switching power supply assembly (which includes the +5 V, ±15 V, +24 V dc and +36 V, -28 V dc switching power supplies), proceed as follows:
   a. Disconnect the cable to the RF Voltage Amplifier PCB from the connector on the RF Voltage Amplifier PCB. (See Figure 5-15 on page 5-44 for the location of the RF Voltage Amplifier PCB, Analyzer Auxiliary PCB, and Waveform Amplifier PCB.)
   b. Disconnect the two cables to the Analyzer Auxiliary PCB from the two connectors on the Analyzer Auxiliary PCB.
   c. Disconnect the cable to the Waveform Amplifier PCB from the connector on the Waveform Amplifier PCB.
   d. Disconnect the cable that is connected to the fan cable.

e. Disconnect the two cables to the Power Module from the two (upper) connectors on the Power Module.

f. Disconnect the cable that is connected to the reset button cable.

g. Loosen by hand (or with a Phillips screwdriver) the fastener that holds the switching power supply assembly to the tower.

h. Remove the switching power supply assembly from the tower.

i. Unpack the new switching power supply assembly (P/N 97000-60151). Retain the packing materials so that you can pack and ship the defective switching power supply assembly to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

j. Install the new switching power supply assembly in the space occupied by the old assembly.

k. Tighten by hand the fastener that holds the switching power supply assembly to the tower.

l. Reconnect the cable that is connected to the reset button cable.

m. Reconnect the two cables to the Power Module to the two (upper) connectors on the Power Module.

n. Reconnect the cable that is connected to the fan cable.

o. Reconnect the cable to the Waveform Amplifier PCB to the connector on the Waveform Amplifier PCB.

p. Reconnect the two cables to the Analyzer Auxiliary PCB to the two connectors on the Analyzer Auxiliary PCB.

q. Reconnect the cable to the RF Voltage Amplifier PCB to the connector on the RF Voltage Amplifier PCB.

Go to step 7.

5. To replace the Turbomolecular Pump Controller, proceed as follows:

a. Disconnect from the Turbomolecular Pump Controller the thick cable to the turbomolecular pump.

b. Disconnect from the Turbomolecular Pump Controller the thin cable that comes from the Power Module.

c. Loosen by hand (or with a Phillips screwdriver) the fastener that holds the Turbomolecular Pump Controller to the tower.

d. Remove the Turbomolecular Pump Controller from the tower.

e. Unpack the new Turbomolecular Pump Controller (P/N 97000-60150). Retain the packing materials so that you can pack and ship the defective Turbomolecular Pump Controller to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

f. Install the new Turbomolecular Pump Controller in the space occupied by the old controller.

g. Tighten by hand the fastener that holds the Turbomolecular Pump Controller to the tower.

h. Reconnect to the Turbomolecular Pump Controller the thin cable that comes from the Power Module.

i. Reconnect to the Turbomolecular Pump Controller the thick cable that goes to the turbomolecular pump.

Go to step 7.

6. To replace the 8 kV power supply, proceed as follows:

   a. Disconnect from the 8 kV power supply the cable that comes from the API panel.

   b. Disconnect from the rear of the System Control PCB (at J5), the thick cable that goes to the System Control PCB.

   c. Loosen by hand (or with a Phillips screwdriver) the fastener that holds the 8 kV power supply to the tower.

   d. Remove the 8 kV power supply from the tower.

   e. Unpack the new 8 kV power supply (P/N 97000-60142). Retain the packing materials so that you can pack and ship the defective 8 kV power supply to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

   f. Reinstall the new 8 kV power supply in the space occupied by the old power supply.

   g. Tighten by hand the fastener that holds the 8 kV power supply to the tower.

   h. Reconnect to the rear of the System Control PCB (at J5), the thick cable that comes from the 8 kV power supply.

   i. Reconnect to the 8 kV power supply the thin cable that comes from the API panel.

   Go to step 7.

7. Return the embedded computer to its original position as follows:

   a. Lift the embedded computer up and away from the MS detector chassis. Lift up the embedded computer a sufficient distance to access the bottom of the embedded computer.

   b. Reconnect to the bottom of the embedded computer the cable that comes from the switching power supplies.

   c. Reconnect the fan power cable to the embedded computer fan. Make sure that the plug on the end of the cable contours the fan (that is, the concave side of the plug is against the fan).

   d. Reposition the embedded computer in its original position in front of the tower.

e. Tighten the six fasteners that secure the embedded computer to the vacuum manifold, base plate, and chassis.

f. Reconnect the cables that connect to the top of the embedded computer. See Figure 5-14 on page 5-42 and Figure 5-15 on page 5-44.

8. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** on page 5-16.
9. Close the front doors of the MS detector.
10. Restart the system as described in the topic **Starting Up the System After a Complete Shutdown** in the **System Shutdown, Startup, and Reset** chapter.
11. Run the LCQDECA diagnostics to verify that the system is operational.

## Replacing PCBs in the Embedded Computer

The Ethernet PCB (P/N 97000-60165), Acquisition DSP PCB (P/N 97000-61260), Control DSP PCB (P/N 97000-61270), Waveform DDS PCB (P/N 97000-61430), and CPU PCB (P/N 97044-60250) reside in the embedded computer. See Figure 5-14.

To replace a PCB in the embedded computer, proceed as follows:

1. Place the electronics service switch in the Service Position (or shut down and vent the LCQDECA system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter).

**CAUTION.** Make sure that the LCQDECA electronic service switch is in the Service Position (or shut down the system and disconnect the power cord) before you proceed.

2. Open the front doors of the MS detector.
3. With a Phillips screwdriver, loosen the two fasteners that hold the front cover to the embedded computer. Remove the front cover of the embedded computer.
4. Locate the PCB you want to replace. See Figure 5-14.
5. Disconnect all electrical cables to the PCB that you want to replace.
6. With a Phillips screwdriver, remove the screw that holds the PCB to the card cage.

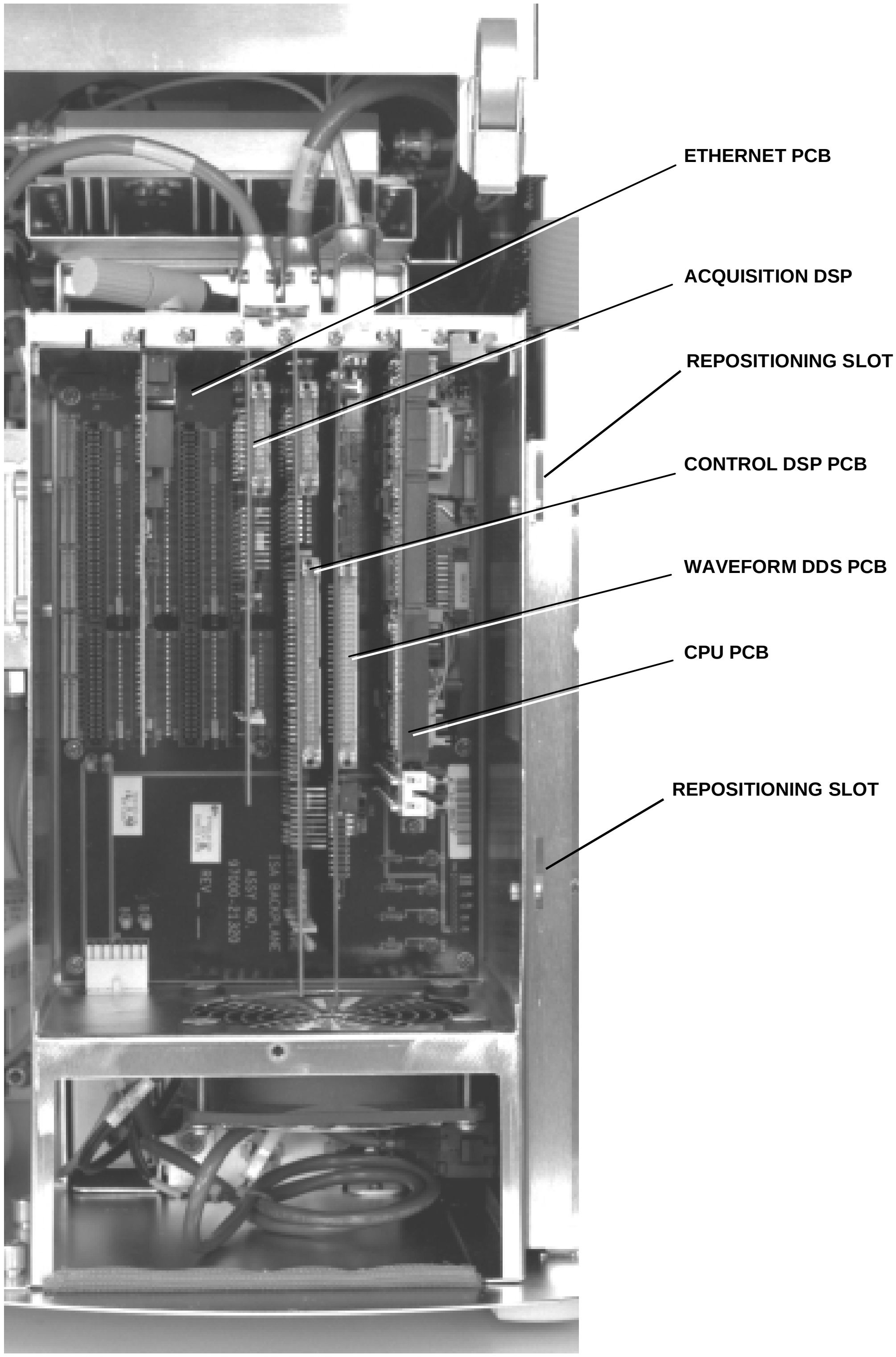



**Figure 5-14. Embedded computer (with front cover removed)**

> **Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

7. Unseat the PCB from the backplane and pull it out of the embedded computer.
8. Unpack the new PCB. Retain the packing materials so that you can pack and ship the defective PCB to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**
9. Seat the new PCB in the backplane.
10. With a Phillips screwdriver, reinstall the screw that holds the PCB to the card cage.
11. Reconnect all electrical cables to the PCB that you replaced.
12. Reinstall the front cover of the embedded computer. Tighten by hand the two fasteners that hold the front cover to the embedded computer.
13. Close the front doors to the MS detector.
14. Place the electronics service switch in the Operating Position.
15. Run the LCQDECA diagnostics to verify that the system is operational.

## Replacing the Vent Delay PCB and Backup Battery, Ion Gauge, and Vent Valve

The Vent Delay PCB, ion gauge, and vent valve can be accessed from the top of the MS detector. See Figure 5-15.

> **CAUTION.** The LCQDECA system must be shut down and the power cord unplugged before you service the vent valve, Vent Delay PCB, Convectron gauge, or ion gauge.

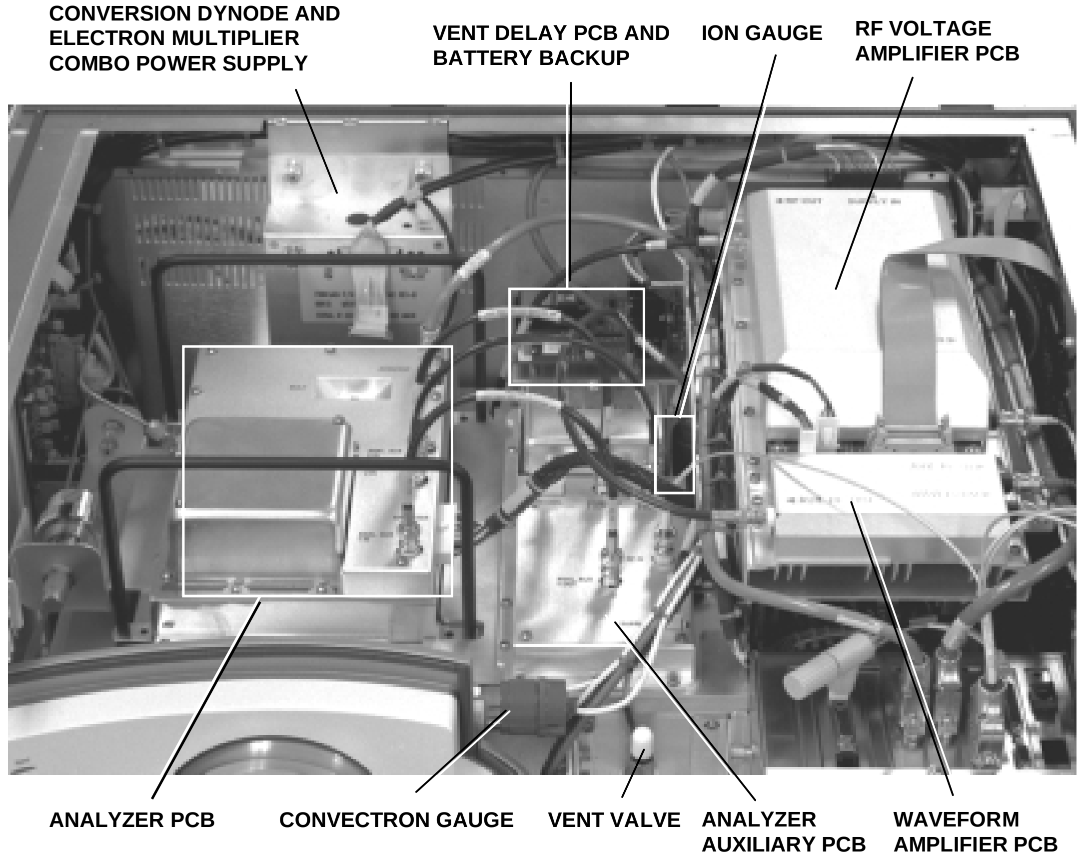
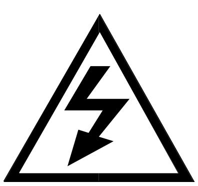



**Figure 5-15. PCBs and assemblies that are accessable from the top of the MS detector**

To replace the Vent Delay PCB, vent valve, or ion gauge, proceed as follows:

1. Shut down and vent the LCQDECA system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter.



**CAUTION.** Make sure that the LCQDECA power cord is unplugged before you proceed.

2. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** on page 5-6.
   - To replace the Vent Delay PCB and backup battery, go to step 3.
   - To replace the vent valve, go to step 4.
   - To replace the ion gauge, go to step 5.

3. To replace the Vent Delay PCB, proceed as follows:
   a. Disconnect at J1 the cable to the vent valve.
   b. Disconnect at J2 the cable to the Power Module.
   c. With a Phillips screwdriver, loosen the four screws that secure the Vent Delay PCB to the MS detector chassis. Remove the Vent Delay PCB.
   d. Unpack the new Vent Delay PCB (P/N 97000-61370). Retain the packing materials so that you can pack and ship the defective PCB to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**
   e. Replace the battery (P/N 00301-05720) if necessary. To replace the battery on the Vent Delay PCB, proceed as follows. See Figure 5-15 on page 5-44 for the location of the battery. Remove the battery from the Vent Delay PCB. Reinstall a new battery (P/N 00301-05720) in the place occupied by the old battery.
   f. Position the new Vent Delay PCB in the space that was occupied by the old PCB.
   g. With a Phillips screwdriver, tighten the four screws that secure the Vent Delay PCB.
   h. Reconnect at J1 the cable that goes to the vent valve.
   i. Reconnect at J2 the cable that comes from the Power Module.

   Go to step 6.
4. To replace the vent valve, proceed as follows:
   a. Disconnect the cable that comes from the Vent Delay PCB.
   b. With a 7/16-in. open-end wrench, loosen the fitting to the vent valve solenoid. Remove the vent valve.
   c. Replace the old vent valve with a new one (P/N 97000-60128)
   d. With a 7/16-in. open-end wrench, tighten the fitting to the vent valve solenoid.
   e. Reconnect the cable that comes from the Vent Delay PCB.

   Go to step 6.
5. To replace the ion gauge, proceed as follows:
   a. Disconnect the cable from the top of the ion gauge by pulling it free from the ion gauge.
   b. Unscrew the ion gauge by hand from the vacuum manifold.
   c. Replace the old ion gauge with a new one (P/N 00105-01525). Screw it into the vacuum manifold.
   d. Reattach the cable to the top of the ion gauge.

   Go to step 6.

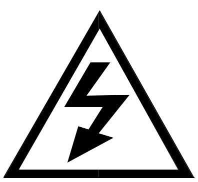
6. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** on page 5-16.
7. Restart the system as described in the topic **Starting Up the System After a Complete Shutdown** in the **System Shutdown, Startup, and Reset** chapter.

## Replacing the Electron Multiplier and Conversion Dynode Power Supplies, Analyzer PCB, Analyzer Auxiliary PCB, Waveform Amplifier PCB, RF Voltage Amplifier PCB

The electron multiplier power supply, conversion dynode power supply, Analyzer PCB, Analyzer Auxiliary PCB, Waveform Amplifier PCB, RF Voltage Amplifier PCB, and battery (battery backup) are accessible from the top of the MS detector. See Figure 5-15 on page 5-44.

To replace the electron multiplier power supply, conversion dynode power supply, Analyzer PCB, Analyzer Auxiliary PCB, Waveform Amplifier PCB, RF Voltage Amplifier PCB, or battery (battery backup), proceed as follows:

1. Place the electronics service switch in the Service Position (or shut down and vent the LCQDECA system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter).



**CAUTION.** Make sure that the LCQDECA electronic service switch is in the Service Position (or shut down the system and disconnect the power cord) before you proceed.

2. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** on page 5-6.
   - To replace the electron multiplier power supply and the conversion dynode power supply, go to step 3.
   - To replace the Analyzer PCB, go to step 4.
   - To replace the Analyzer Auxiliary PCB, go to step 5.
   - To replace the Waveform Amplifier PCB, go to step 6.
   - To replace the RF Voltage Amplifier PCB, go to step 7.

3. To replace the electron multiplier power supply and/or the conversion dynode power supply, proceed as follows. See Figure 5-15 on page 5-44 for the location of the electron multiplier and conversion dynode power supplies.

   a. Disconnect the conversion dynode high voltage cable at the conversion dynode feedthrough by pulling it free from the feedthrough.

   b. Disconnect the electron multiplier high voltage cable at the electron multiplier power supply.

   c. Disconnect from the top of the electron multiplier and conversion dynode power supplies the electrical cable that comes from the System Control PCB.

   d. Loosen by hand or with a Phillips screwdriver the two fasteners that hold the electron multiplier and conversion dynode power supply module to the MS detector chassis.

   e. Carefully lift the electron multiplier and conversion dynode power supply module up and away from the MS detector.

   f. You must replace the conversion dynode power supply and the electron multiplier power supply together as a module (P/N 97000-98042). Retain the packing materials so that you can pack and ship the defective power supply module or PCB to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

   g. Install the electron multiplier and conversion dynode power supply module in the space occupied by the old power supply module.

   h. With a Phillips screwdriver, tighten the two fasteners that hold the electron multiplier and conversion dynode power supply module to the MS detector chassis.

   i. Reconnect to the electron multiplier and conversion dynode power supplies the electrical cable that comes from the System Control PCB.

   j. Reconnect the electron multiplier high voltage cable to the electron multiplier power supply.

   k. Reconnect the conversion dynode high voltage cable to the conversion dynode feedthrough.

   Go to step 8.

4. To replace the Analyzer PCB, proceed as follows. See Figure 5-15 on page 5-44 for the location of the Analyzer PCB.
   a. Disconnect (at P5) the octapoles cable that comes from the Analyzer Auxiliary PCB.
   b. Disconnect (at P4) the lenses cable that comes from the System Control PCB.
   c. Disconnect (at P2 and P3) the two endcap electrode cables that come from the Analyzer Auxiliary PCB.
   d. Disconnect (at P1) the electrometer cable. (If necessary, use a small screw driver to loosen the screws that secure the cable.)
   e. Disconnect the electron multiplier high voltage cable that comes from the electron multiplier power supply.
   f. Use a 7/16-in. open-end wrench to disconnect the helium damping gas line from the fitting.
   g. With a Phillips screwdriver, remove the metal cover from the Analyzer PCB.
   h. With a Phillips screwdriver, remove the screws that hold the Analyzer PCB to the top cover plate of the vacuum manifold.

> **Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

   i. Unseat and remove the Analyzer PCB from the top cover plate.
   j. Unpack the new Analyzer PCB (P/N 97033-61051). Retain the packing materials so that you can pack and ship the defective PCB to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**
   k. Carefully align and seat the Analyzer PCB into the 8-pin and 4-pin feedthroughs on the top cover plate.
   l. With a Phillips screwdriver, reinstall the screws that hold the Analyzer PCB to the top cover plate.
   m. With a Phillips screwdriver, reinstall the metal cover.
   n. Use a 7/16-in. open-end wrench to reconnect the helium damping gas line to the fitting.
   o. Reconnect (at P5) the octapoles cable that comes from the Analyzer Auxiliary PCB.
   p. Reconnect (at P4) the lenses cable that comes from the System Control PCB.
   q. Reconnect (at P2 and P3) the two endcap cables that come from the Analyzer Auxiliary PCB.

r. Reconnect (at P1) the electrometer cable.

s. Reconnect the electron multiplier high voltage cable that comes from the electron multiplier power supply.

Go to step 8.

5. To replace the Analyzer Auxiliary PCB, proceed as follows. See Figure 5-15 page 5-44 for the location of the Analyzer Auxiliary PCB.

a. Disconnect all cables to the Analyzer Auxiliary PCB.

**Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

b. With a Phillips screwdriver, remove the metal cover from the Analyzer Auxiliary PCB.

c. With a Phillips screwdriver, remove the screws that hold the Analyzer Auxiliary PCB to the top of the vacuum manifold. Remove the Analyzer Auxiliary PCB.

d. Unpack the new Analyzer Auxiliary PCB (P/N 97000-61340). Retain the packing materials so that you can pack and ship the defective PCB to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

e. Install the new PCB in the place occupied by the old PCB.

f. With a Phillips screwdriver, reinstall the screws that secure the Analyzer Auxiliary PCB to the top of the vacuum manifold.

g. Reinstall the metal cover to the top of the Analyzer Auxiliary PCB.

h. Reconnect all cables to the Analyzer Auxiliary PCB that you disconnected in step 5a.

Go to step 8.

6. To replace the Waveform Amplifier PCB, proceed as follows. See Figure 5-15 on page 5-44 for the location of the Waveform Amplifier PCB.

a. Disconnect all cables to the Waveform Amplifier PCB.

**Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

b. With a Phillips screwdriver, remove the metal cover from the Waveform Amplifier PCB.

c. With a Phillips screwdriver, remove the screws that secure the Waveform Amplifier PCB to the top of the tower. Remove the Waveform Amplifier PCB.

d. Unpack the new Waveform Amplifier PCB (P/N 96000-61110). Retain the packing materials so that you can pack and ship the defective PCB to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

e. Install the new PCB in the place occupied by the old PCB.

f. With a Phillips screwdriver, reinstall the screws that secure the Waveform Amplifier PCB to the top of the tower.

g. Reinstall the metal cover to the top of the Waveform Amplifier PCB.

h. Reconnect all cables to the Waveform Amplifier PCB that you disconnected in step 6a.

Go to step 8.

7. To replace the RF Voltage Amplifier PCB, proceed as follows:

a. Disconnect all cables to the RF Voltage Amplifier PCB.

**Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

b. With a Phillips screwdriver, remove the metal cover from the RF Voltage Amplifier PCB.

c. With a Phillips screwdriver, remove the screws that secure the RF Voltage Amplifier PCB to the top of the tower. Remove the RF Voltage Amplifier PCB.

d. Unpack the new RF Voltage Amplifier PCB (P/N 97000-61090). Retain the packing materials so that you can pack and ship the defective PCB to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

e. Install the new PCB in the place occupied by the old PCB.

f. With a Phillips screwdriver, reinstall the screws that secure the RF Voltage Amplifier to the top of the tower.

g. Reinstall the metal cover to the top of the RF Voltage Amplifier PCB.

h. Reconnect all cables to the RF Voltage Amplifier PCB that you disconnected in step 7a.

Go to step 8.

8. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** on page 5-16.
9. Place the electronics service switch in the Operating Position.
10. Run the LCQDECA diagnostics to verify that the system is operational.
11. If you replaced the Analyzer PCB, Analyzer Auxiliary PCB, or RF Voltage Amplifier PCB, tune the ring electrode and quadrupole/octapole RF voltages as described in the topic **Tuning the Ring Electrode and Quadrupole/Octapole RF Voltages** on page 5-16.

## Replacing the System Control PCB

To replace the System Control PCB, proceed as follows. See Figure 5-12 on page 5-33 for the location of the System Control PCB.

1. Place the electronics service switch in the Service Position (or shut down and vent the LCQDECA system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter).

> **CAUTION.** Make sure that the LCQDECA electronic service switch is in the Service Position (or shut down or shut down the system and disconnect the power cord) before you proceed.

2. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** on page 5-6.
3. Remove the right side cover of the MS detector, as follows:
   a. Loosen the fastener that secures the right side cover to the chassis of the MS detector.
   b. Slide the side cover back about 1.2 cm (0.5 in.), and then pull it out and away from the MS detector.
4. Remove the System Control PCB protective cover, as follows:
   a. With Phillips screwdriver, loosen the five screws that hold the protective cover to the MS detector chassis.
   b. Pull the cover up and out of the guide slots on the MS detector chassis.

5. Disconnect all cables to the System Control PCB. The following cables are connected to the System Control PCB:
   - Ion gauge / Convectron gauge (P9)
   - Front panel (P2)
   - Analyzer (J3)
   - Spray shield (J6)
   - RF and waveform amplifiers (P12)
   - Analyzer Aux. (P5)
   - Electron multiplier / conversion dynode power supplies (P3)
   - RF control (P8)
   - LC I/O (P4)
   - Switching power supplies (J2)
   - APCI heater (J4)
   - Transformer (XMFR) (P1)
   - High speed serial (P6 backside of PCB)
   - 8 kV power supply (J5 backside of PCB)
6. With a Phillips screwdriver, loosen the eight fasteners that hold the System Control PCB to the MS detector chassis.

> **Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

7. Slide the System Control PCB toward the front of the MS detector by 1.2 cm (0.5 in.) so that it clears the data system cable connector.
8. Carefully lift the System Control PCB out and away from the MS detector. Disconnect the high speed serial cable and 8 kV power supply cables if you have not already done so.
9. Unpack the new System Control PCB (P/N 97044-61010). Retain the packing materials so that you can pack and ship the defective PCB to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**
10. Position the new System Control PCB in the space occupied by the old PCB.
11. With a Phillips screwdriver, tighten the three screws and the eight fasteners that hold the System Control PCB to the MS detector chassis.

12. Reconnect all cables to the System Control PCB. The following cables are connected to the System Control PCB:
    - Ion gauge / Convectron gauge (P9)
    - Front panel (P2)
    - Analyzer (J3)
    - Spray shield (J6)
    - RF and waveform amplifiers (P12)
    - Analyzer Aux. (P5)
    - Electron multiplier / conversion dynode power supplies (P3)
    - RF control (P8)
    - LC I/O (P4)
    - Switching power supplies (J2)
    - APCI heater (J4)
    - Transformer (XMFR) (P1)
    - High speed serial (P6 backside of PCB)
    - 8 kV power supply (J5 backside of PCB)
13. Reinstall the protective cover over the System Control PCB, as follows:
    a. Insert the protective cover into the guide slots on the MS detector chassis and push the cover down until it is seated.
    b. With Phillips screwdriver, tighten the five screws that hold the protective cover to the MS detector chassis.
14. Reinstall the right side cover of the MS detector, as follows:
    a. Place the cover against the right side of the MS detector such that the studs on the cover insert into the guide slots on the System Control PCB protective cover.
    b. Slide the side cover forward about 1.2 cm (0.5 in.) until the studs on the cover lock in the guide slots.
    c. Tighten by hand the fastener that secures the side cover to the chassis of the MS detector.
15. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** on page 5-16.
16. Place the electronics service switch in the Operating Position.
17. Run the LCQDECA diagnostics to verify that the system is operational.

# Replacing the RF Voltage Control PCB

To replace the RF Voltage Control PCB (and its housing), proceed as follows. See Figure 5-16 for the location of the RF Voltage Control PCB.

1. Place the electronics service switch in the Service Position (or shut down and vent the LCQDECA system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter).

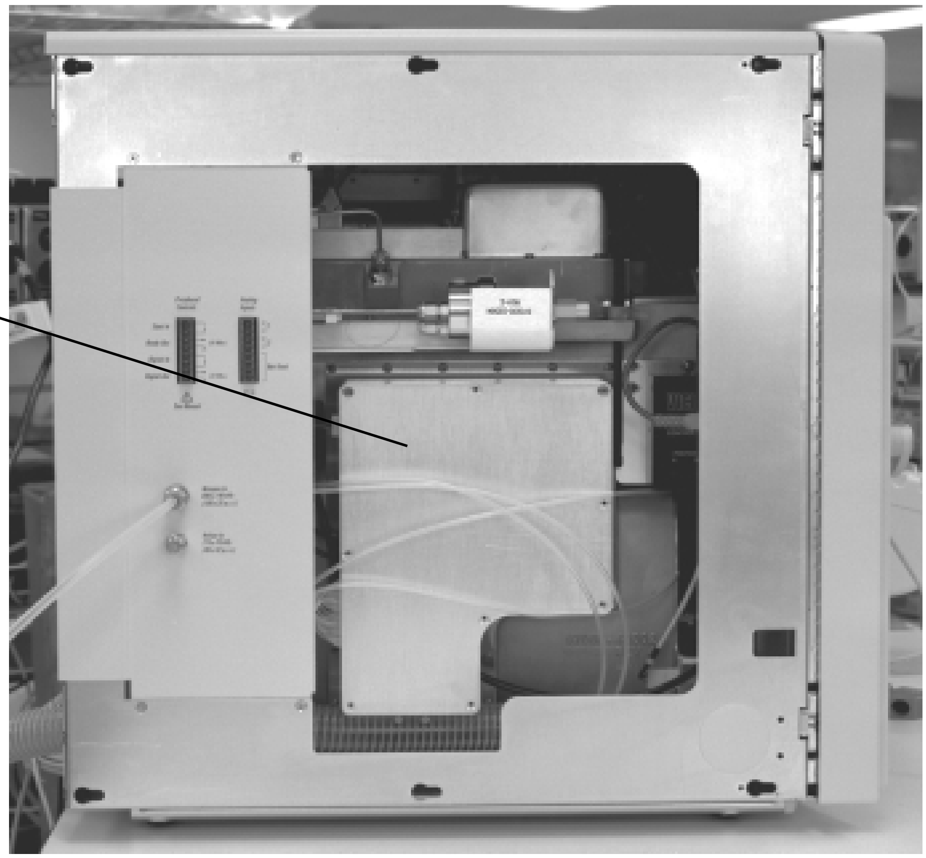



**Figure 5-16. Left side of the MS detector, showing the RF Voltage Control PCB**

**CAUTION.** Make sure that the LCQDECA electronic service switch is in the Service Position (or shut down or shut down the system and disconnect the power cord) before you proceed.

2. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** on page 5-6.

3. Remove the left side cover of the MS detector, as follows:
    a. Loosen the fastener that secures the left side cover to the chassis of the MS detector.
    b. Slide the side cover back about 1.25 cm (0.5 in.), and then pull it out and away from the MS detector.

> **Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

4. With a Phillips screwdriver, remove the nine screws that secure the front cover of the RF Voltage Control PCB. Remove the front cover to expose the RF Voltage Control PCB.
5. Disconnect the cable that comes from the RF Voltage Amplifier PCB.
6. Disconnect the cable that comes from the System Control PCB.
7. With a Phillips screwdriver, remove the screws that hold the RF Voltage Control PCB housing to the vacuum manifold. Remove the RF Voltage Control PCB and its housing as a unit. Reinstall the cover plate on the housing.
8. Unpack the new RF Voltage Control PCB and housing (P/N 96000-61100). Retain the packing materials so that you can pack and ship the defective PCB and housing to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**
9. Position the new RF Voltage Control PCB and its housing against the vacuum manifold where the old assembly was located. With a Phillips screwdriver, reinstall the 21 screws that hold the RF Voltage Control PCB housing to the vacuum manifold.
10. With a Phillips screwdriver, remove the nine screws that hold the front cover of the RF Voltage Control PCB housing to the RF Voltage Control PCB housing. Remove the front cover to expose the RF Voltage Control PCB.
11. Reconnect the cable that comes from the System Control PCB.
12. Reconnect the cable that comes from the RF Voltage Amplifier PCB.
13. Position the front cover over the RF Voltage Control PCB. With a Phillips screwdriver, reinstall the screws that hold the front cover to the RF Voltage Control PCB housing.
14. Reinstall the left side cover of the MS detector as follows:
    a. Place the cover against the left side of the MS detector such that the studs on the cover insert into the guide slots in the MS detector chassis.

   b. Slide the side cover forward about 1.25 cm (0.5 in.) until the studs on the cover lock in the guide slots.

   c. Tighten by hand the fastener that secures the side cover to the chassis of the MS detector.

15. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** on page 5-16.

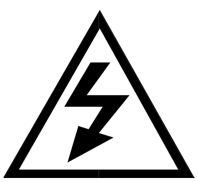
16. Place the electronics service switch in the Operating Position.

17. Run the LCQDECA diagnostics to verify that the system is operational.

## Replacing the Low Pass Filter PCB

To replace the Low Pass Filter PCB, proceed as follows. See Figure 5-17 for the location of the Low Pass Filter PCB.

1. Place the electronics service switch in the Service Position (or shut down and vent the LCQDECA system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter).



> **CAUTION.** Make sure that the LCQDECA electronic service switch is in the Service Position (or shut down or shut down the system and disconnect the power cord) before you proceed.

2. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** on page 5-6.

3. Remove the rear cover of the MS detector as follows:

   a. With a Phillips screwdriver, loosen the 10 screws that secure the rear cover to the chassis of the MS detector.

   b. Slide the rear cover up about 1.25 cm (0.5 in.), and then lift it out and away from the MS detector.

4. Disconnect the two coaxial cables from the BNC connectors that are located on the rear of the Low Pass Filter PCB.

> **Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

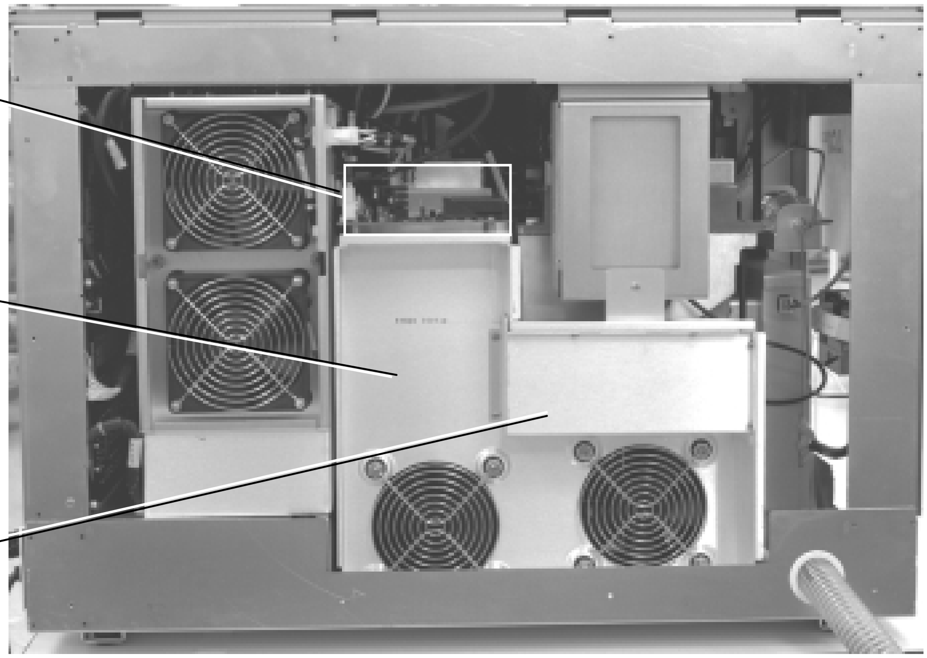



**Figure 5-17. Rear view of the MS detector, showing the Vent Delay PCB, and Low Pass Filter PCB**

5. With a Phillips screwdriver, remove the 8 screws that hold the metal cover of the Low Pass Filter PCB to the fan, low pass filter, vent control assembly. Remove the metal cover.
6. With a Phillips screwdriver, remove the screws that hold the Low Pass Filter PCB to the fan, low pass filter, vent control assembly. Remove the Low Pass Filter PCB.
7. Unpack the new PCB (P/N 97000-61380). Retain the packing materials so that you can pack and ship the defective PCB to the ThermoQuest Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**
8. Position the new Low Pass Filter PCB in the place that was occupied by the old PCB. With a Phillips screwdriver, reinstall the screws that hold the Low Pass Filter PCB to the fan, low pass filter, vent control assembly.
9. Position the metal cover over the Low Pass Filter PCB. With a Phillips screwdriver, reinstall the 8 screws that hold the metal cover of the Low Pass Filter PCB to the fan, low pass filter, vent control assembly.
10. Reconnect the two coaxial cables to the BNC connectors that are located on the rear of the Low Pass Filter PCB.
11. Reinstall the rear cover of the MS detector as follows:
    a. Place the cover against the rear of the MS detector such that the screws in the MS detector chassis insert into the guide slots on the rear cover.

b. Slide the rear cover down about 1.2 cm (0.5 in.) until the screws lock in the guide slots on the cover.

c. With a Phillips screwdriver, tighten the ten screws that secure the rear cover to the chassis of the MS detector.

12. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** on page 5-16.
13. Place the electronics service switch in the Operating Position.
14. Run the LCQDECA diagnostics to verify that the system is operational.

# 5.8 Replacing the Oil Reservoir in the Turbomolecular Pump

You need to replace the oil reservoir in the turbomolecular pump at least once a year. Replacing the oil reservoir in the turbomolecular pump involves the following steps:

- Removing the turbomolecular pump
- Changing the turbomolecular pump oil reservoir
- Reinstalling the turbomolecular pump

**Note.** If the turbomolecular pump fails, it must be replaced (P/N 00108-02642). To replace the turbomolecular pump, remove the pump as described in the topic **Removing the Turbomolecular Pump**. Then, install a new pump as described in the topic **Reinstalling the Turbomolecular Pump**.

## Removing the Turbomolecular Pump

To remove the turbomolecular pump, proceed as follows:

1. Shut down and vent the system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter.
2. Open the left and right front doors of the MS detector by loosening the 1/4-in. Allen screw on the right front door with an Allen wrench. (Disconnect any sample tubes between the syringe pump and the API source before opening the right front door.)
3. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** on page 5-6.
4. Loosen the red hose clamp (Edwards, KF20) that secures the vacuum hose to the turbomolecular pump. See Figure 5-18. Disconnect the vacuum hose from the turbomolecular pump. Remove the centering ring from the vacuum hose.
5. Disconnect the power cable from the turbomolecular pump.
6. With a 3/16-in. ball driver or Allen wrench, carefully loosen the two Allen screws that hold the rails and turbomolecular pump to the vacuum manifold.

7. Pull the turbomolecular pump out on the rails. If necessary, disconnect one or more of the vacuum hoses at the foreline union by loosening the clamping rings and then pulling the hoses free from the foreline union.
8. Remove the turbomolecular pump.

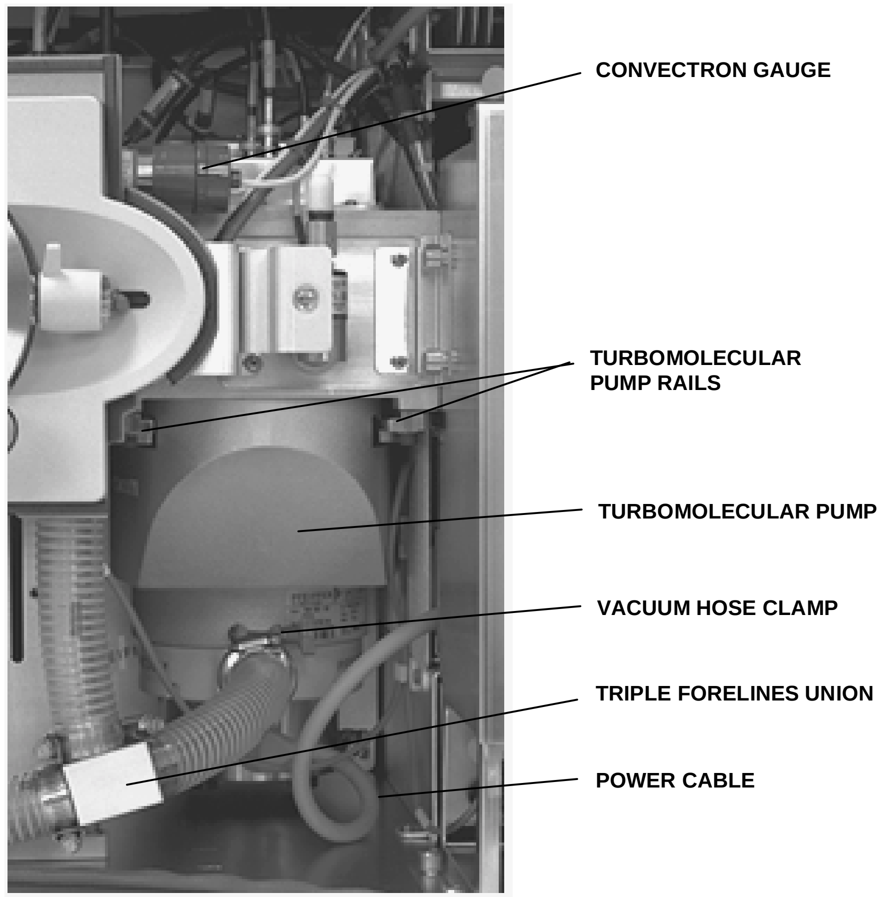



**Figure 5-18. Turbomolecular pump**

## Changing the Turbomolecular Pump Oil Reservoir

To change the turbomolecular pump oil reservoir, proceed as follows:

> **CAUTION.** Toxic residues from samples are likely to be concentrated in the pump oil. Spent pump oil must be disposed of in accordance with local and federal regulations.

1. Turn the turbomolecular pump upside down on a work bench.
2. Using a large screwdriver, unscrew the locking cap on the bottom of the turbomolecular pump. Remove the locking cap and O-ring.
3. Using a pair of tweezers, remove the oil reservoir from the pump. Dispose of the oil reservoir properly.
4. Place a new oil reservoir (P/N 00950-01116) in the cavity in the bottom of the pump.
5. Check the condition of the Viton O-ring. If it has any nicks or breaks, replace it with a new one.
6. Reinstall the O-ring and locking cap. Tighten the locking cap securely with a large screwdriver.

## Reinstalling the Turbomolecular Pump

To reinstall the turbomolecular pump, proceed as follows. See Figure 5-18.

1. Check the condition of the Viton O-rings around the two openings on the bottom of the vacuum manifold. (Use a small flashlight to illuminate the O-rings.) If they have any nicks or breaks, replace them with new ones (P/N 00107-11100).
2. Place the turbomolecular pump on the turbomolecular pump rails.
3. Slide the turbomolecular pump into position under the openings in the vacuum manifold.
4. With a 3/16-in. ball driver or Allen wrench, carefully tighten the two Allen screws that hold the rails and turbomolecular pump to the vacuum manifold. Do not overtighten the screws.
5. Place the centering ring in the end of the vacuum hose. Reconnect the vacuum hose (with the centering ring in place) to the turbomolecular pump. Tighten the red hose clamp (Edwards, KF20) that secures the vacuum hose to the turbomolecular pump.
6. Reconnect the turbomolecular pump power cable.

7. If necessary, reconnect the vacuum hoses to the foreline union. Tighten the clamping rings to secure the vacuum hoses to the foreline union.
8. Reinstall the top cover of the MS detector by following the procedure in the topic **Reinstalling the Top Cover of the MS Detector** on page 5-16.
9. Close the left and right front doors of MS detector.
10. Reconnect any tubing between the syringe pump and the API source that you disconnected earlier.

Restart the system as described in the topic **Starting Up the System After a Complete Shutdown** in the **System Shutdown, Startup, and Reset** chapter.

# Chapter 6
# Replaceable Parts

This chapter contains part numbers for replaceable and consumable parts for the MS detector, data system, and kits. To ensure proper results in servicing the LCQDECA system, order only the parts listed or their equivalent.

For information on how to order parts, refer to the topic **Ordering Replaceable Parts** in the **Finnigan LCQDECA Preinstallation Requirements Guide**.

# MS Detector

Replaceable parts are available to support the following:

- ESI probe assembly
- APCI probe assembly
- API probe guide
- API stack
- Ion optics
- Mass analyzer
- Ion detection system (electron multiplier/conversion dynode)
- Top cover plate of vacuum manifold
- Divert/inject valve
- Syringe pump
- Turbomolecular pump
- Rotary-vane pumps
- Vacuum system assemblies
- Mechanical assemblies
- Electrical assemblies
- Printed circuit boards (PCBs)
- RF control/detection assemblies
- Cables
- Covers

# ESI Probe Assembly

**Assembly, ESI Probe ........................................................................................ 97044-60110**

Connector, receptacle, HV, shielded..................................................................00004-89626
Container, ESI and APCI probes.......................................................................00707-10030
Ferrule, 0.008-in. ID, KEL-F®, HPLC ..............................................................00101-18114
Ferrule, 0.016-in. ID, PEEK (polyetheretherketone) HPLC ..............................00101-18120
Ferrule, 0.027-in. ID, PEEK HPLC...................................................................00101-18119
Fitting, HPLC, adapter, 10-32 × ¼-in., KEL-F ..................................................00101-18080
Fitting, finger nut, HPLC, 10-32, PEEK............................................................00101-18081
Fitting, ferrule, 1/8-in., Tefzel®.........................................................................00101-18199
Fitting, Fingertight 2, Upchurch.........................................................................00101-18195
Fitting, flangeless, stainless steel, 1/8-in., blue, Delrin® ...................................00101-18200

Fitting, flangeless, stainless steel, 1/8-in., green, Delrin ....................................00101-18198
Fitting, transfer line, internal union, 1/16-in., stainless steel ..............................00101-18182
Fitting, plug, 1/4-in. × 28, Tefzel, HPLC ..........................................................00101-18075
Flange, ESI.......................................................................................................97044-20031
Manifold, ESI, API2.........................................................................................70005-20300
Needle, ESI, D point, 26 gauge, 2-in. long .......................................................00950-00990
Nozzle, ESI, API2 ............................................................................................70005-20299
O-ring, 0.114-in. ID, 1/16-in. thick, Viton® ......................................................00107-02550
O-ring, 0.676-in. ID, 0.070-in. thick, Viton.......................................................00107-05710
O-ring, 3.737-in. ID, 0.103-in. thick, Viton.......................................................00107-10058
Plunger, ball, 1/4-in. × 20, 0.53-in. long, 4 lb-ft ................................................00201-11716
Probe, ESI.......................................................................................................97044-60100
Resistor, FXD, CC, ¼ W, 10 kΩ, 5%...............................................................00015-17600
Retainer, seal...................................................................................................70005-20280
Screw, flat, Phillips, 4-40 × 3/4-in., stainless steel............................................00407-44006
Screw, pan head, Phillips, 4-40 × 3/8-in., stainless steel ...................................00405-44020
Screw, thumb, ESI probe retainer bolt...............................................................70005-20303
Screw, thumb, flange retainer bolt (2 each) ......................................................70005-20297
Seal, Bal, 2.0-in. ID, light load API2 .................................................................00107-18010
Seal, standard, needle, 5000 series, Teflon®.....................................................00950-00952
Spring, compression, 0.088-in. OD, 0.62-in. long, stainless steel......................00201-11529
Spring contact, .................................................................................................70005-20228
Spring, spiral wave, 1.14-in. ID x 0.4-in length, stainless steel .........................00201-11596
Tubing, fused silica, 0.1 mm ID × 0.4 mm OD, deactivated (1 m) *l* ..................00106-10504
Tubing, fused silica, 0.1 mm ID × 0.190 mm OD, 6 ft. (1.8 m) *l* ......................00106-10499

# APCI Probe Assembly

**Assembly, APCI Probe..........................................................................97044-60140**

O-ring, 0.145-in. ID, 1/16-in. thick, Viton........................................................00107-02562
O-ring, 3.737-in. ID, 0.103-in. thick, Viton.......................................................00107-10058
O-ring, 0.801-in. ID, 0.070-in. thick, Viton.......................................................00107-15300
Plunger, spring, 6-32 × 3/8-in. long .................................................................00201-11450

**APCI Probe ..........................................................................................70005-60075**

Ferrule, 0.016-in. ID, PEEK, HPLC.................................................................00101-18120
Ferrule, Fingertight 2, Upchurch.......................................................................00101-18196
Fitting, 10-32, male nut, PEEK.........................................................................70005-20220
Fitting, APCI flange .........................................................................................70005-20250
Fitting, ferrule, 1/8-in., Tefzel...........................................................................00101-18199
Fitting, Fingertight 2, Upchurch........................................................................00101-18195
Fitting, flangeless, stainless steel, 1/8-in., blue, Delrin .....................................00101-18200
Fitting, flangeless, stainless steel, 1/8-in., green, Delrin ...................................00101-18198
Heater coil, APCI .............................................................................................70005-20216
Insulator, heater, APCI .....................................................................................70005-20195
Manifold, APCI.................................................................................................70005-20201
Nozzle, APCI ...................................................................................................70005-20196
O-ring, 0.185-in. ID, 0.056-in. thick, Viton.......................................................00107-02585

O-ring, 0.239-in. ID, 1/16-in. thick, Viton ........ 00107-04000
O-ring, 0.614-in. ID, 1/16-in. thick, Viton ........ 00107-05700
O-ring, 0.625-in. ID, 0.029-in. thick, Viton ........ 00107-09015
Retainer, heater, APCI ........ 70005-20222
Screw, pan head, Phillips, 4-40 × 1/8-in., stainless steel ........ 00405-44050
Screw, socket, 4-40 × 3/16-in., stainless steel, silver plated ........ 00419-44005
Tube, auxiliary gas, APCI ........ 70005-20199
Tube, sheath gas, APCI ........ 70005-20200
Tube, vaporizer, APCI ........ 70005-20194
Tubing, fused silica, 0.150 mm ID × 0.363 mm OD, 2 ft. (0.6 m) *l* ........ 00106-10498
Vaporizer casing, APCI ........ 70005-20217
Vaporizer flange, APCI ........ 70005-20239
Washer, flat, #4, 0.312-in. OD × 0.03-in. thick, stainless steel ........ 00470-00410

**Vaporizer Kit ........ 97000-62037**

Heater coil, APCI ........ 70005-20216
Insulator, heater, APCI ........ 70005-20195
Screw, socket, 4-40 × 3/16-in., stainless steel, silver plated ........ 00419-44005
Tube, vaporizer, APCI ........ 70005-20194
Washer, flat, #4, 0.312-in. OD × 0.03-in. thick, stainless steel ........ 00470-00410

**Assembly, Corona Discharge ........ 70005-60105**

Bulkhead nut, corona tube ........ 70005-20227
Compression nut, corona tube ........ 70005-20226
Connector, receptacle, HV, shielded ........ 00004-89626
Contacting, socket, Be-Cu ........ 70001-30016
Corona tube, APCI ........ 70005-20225
Needle housing, corona tube ........ 70005-20296
Needle, corona ........ 70005-98033
O-ring, 0.176-in. ID, 1/16-in. thick, Viton ........ 00107-02575
Resistor, fixed, carbon composite, 1/4 W, 22 MΩ, 5% ........ 00015-27820
Screw-set, socket, 2-56 × 1/16-in., stainless steel ........ 00451-08025
Spring contacting, corona tube ........ 70005-20228
Spring, compression, stainless steel ........ 00201-11523

Screw, thumb, APCI probe retainer bolt ........ 97000-20268

Screw, thumb, API flange retainer bolt ........ 97000-20304

# API Probe Guide

**Kit, Guide, API Probe ........ 97000-62009**

Adapter, slide, API probe ........ 97000-20270
Guide, API probe flange ........ 97000-20232
O-ring, 0.237-in. ID, 0.103-in. thick, Viton ........ 00107-12250
O-ring, 0.296-in. ID, 0.139-in. thick, Viton ........ 00107-04210
Plate, slide handle ........ 97000-20285
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel ........ 00415-63208
Screw, thumb, 1/2-in. × 20, UNC, API probe ........ 97000-20286

Shaft, left, API slide ........................................ 97000-20261

**Kit, API, Micro Switch ........................................ 97000-62017**

Switch, leaf roller, SPDT, 0.5 A ........................................ 00019-27060

## API Stack

**Assembly, API Stack ........................................ 97044-60150**

Bushing, heated capillary mount ........................................ 97000-20281
Fitting, 3/8-in. hose, 1 1/2-in. × 13, UNC, male ........................................ 97000-20269
Heated capillary ........................................ 70005-98041
Mount, heated capillary ........................................ 97000-20202
Mount, tube lens and skimmer ........................................ 97000-20199
O-ring, 0.299-in. ID, 0.103-in. thick, Kalrez® ........................................ 00107-10059
O-ring, 0.364-in. ID, 0.0625-in. thick, Viton ........................................ 00107-05500
O-ring, 0.739-in. ID, 0.070-in. thick, Viton ........................................ 00107-10100
O-ring, 3.850-in. ID, 0.210-in. thick, Viton ........................................ 00107-14100
Plunger, ball, 6-40, 0.310 long, 1 lb-ft ........................................ 00201-11719
Retainer, API connector ........................................ 97000-20320
Screw, pan head, Phillips, 4-40 × 1/4-in., stainless steel ........................................ 00415-44004
Screw, socket, 4-40 × 3/8-in. long, stainless steel ........................................ 00419-44006
Skimmer ........................................ 97000-20201
Sleeve, heated capillary ........................................ 70005-20224
Spray shield ........................................ 97044-60120
Tube lens ........................................ 97000-20200
Vacuum cap, heated capillary ........................................ 70005-20221

## Ion Optics

Lens, interoctapole ........................................ 97044-20004

Mount, analyzer ........................................ 97044-20005

Mount, quadrupole (formerly named octapole mount) ........................................ 97000-20164

Octapole, 2.0-in. long, welded ........................................ 97000-60016

Quadrupole, 2.0-in. long ........................................ 97044-60060

Thumb screw, 10-32 ........................................ 97000-20235

**Kit, Feedthrough, 4 Pin ........................................ 97000-62004**

Feedthrough, 4 pin, modified ........................................ 97000-98016
O-ring, 0.737-in. ID, 3/32-in. thick, Viton ........................................ 00107-10056
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel ........................................ 00415-63208
Spacer, 4 pin feedthrough ........................................ 97000-20226

**Kit, Feedthrough, 8 Pin ........ 97000-62008**

Feedthrough, 8 pin ........ 96000-20115
O-ring, 0.737-in. ID, 3/32-in. thick, Viton ........ 00107-10056
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel ........ 00415-63208
Shield box, PCB ........ 97000-10083
Spacer, 8 pin feedthrough ........ 97000-20225

## Mass Analyzer

Electrode, ring ........ 96000-20016

Electrode, endcap, entrance/exit ........ 97044-20000

Exit lens ........ 97000-20205

Mount, analyzer ........ 97044-20005

Nipple, damping gas ........ 96000-20117

Nut ........ 97000-20339

Post ........ 97000-20338

Sleeve, entrance lens ........ 97044-20002

Sleeve, exit lens ........ 97044-20001

Spacer, ring ........ 97000-20302

Spring washer, 0.33-in. ID, 0.49-in. OD, stainless steel ........ 00474-11618

Tubing, Teflon, 14 gauge, 0.016-in. wall thickness ........ 00007-94320

## Ion Detection System (Electron Multiplier / Conversion Dynode)

Disk, shield, dynode ........ 97000-20263

Shield, dynode ........ 97000-20210

**Kit, Conversion Dynode ........ 97000-62085**

Feedthrough, dynode ........ 97000-60171
O-ring, 1.37-in. ID, 0.103-in. thick, Viton ........ 00107-10400
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel ........ 00415-63208
Spring, coil, 1.358-in. ID, 0.083-in. height. ........ 00201-11680
Tube, shield, dynode ........ 97000-20275

**Kit, Electron Multiplier ........ 96000-62019**

Anode, electron multiplier ........ 96000-20076
Feedthrough, HV ........ 96000-20073
Feedthrough, electron multiplier ........ 96000-20072
O-ring, 0.375-in. ID, 0.103-in. thick, Viton ........ 00107-07000

O-ring, 0.688-in. ID, 0.103-in. thick, Viton ........ 00107-09500
Screw, socket, cap, 2-56 × 1/8-in., vented, stainless steel ........ 00452-20000
Ring, high voltage ........ 96000-20074
Shield, electron multiplier ........ 96000-20071
Support, electron multiplier ........ 96000-20070
Support plate, electron multiplier ........ 96000-20072
Tube, high voltage ........ 96000-20078

**Assembly, Electron Multiplier ........ 96000-60036**

Cathode, electron multiplier ........ 00022-02400
Screw, pan head, Phillips, 2-56 × 1/4-in., vented, stainless steel ........ 00452-25605
Washer, wave, 0.731-in. OD × 0.588-in. ID ........ 00471-50080

# Top Cover Plate of Vacuum Manifold

**Assembly, Top Cover ........ 97044-60030**

Connector, Swagelok®, modified ........ 96000-30005
Fitting, Swagelok, ferrule, 1/8-in., tee set ........ 00101-09250
Fitting, Swagelok, nut knurled, 1/8-in., brass ........ 00101-12902
Nipple, damping gas ........ 96000-20117
Pin guide, large top cover ........ 97000-20267
Pin guide, top cover ........ 97000-20222
Pin, PCB, top cover ........ 97000-20223
Plate, top, manifold ........ 97000-20133

**Kit, Handle Top Cover, 8-in. ........ 97000-62003**

Handle, 8-in., top cover ........ 97000-20220

# Divert/Inject Valve

**Interconnect Assembly, Divert/Inject Valve ........ 97000-60159**

Divert/inject valve, 24 V dc ........ 00110-09998
Screw, flat, Phillips, 8-32 × 3/8-in., zinc ........ 00407-83205
Screw, pan head, Phillips, 6-32 × 3/8-in., stainless steel ........ 00415-63206
Spacer, 0.125-in. long, #6. ID, 1/4-in. OD, stainless steel ........ 00007-68301

# Syringe Pump

**Interconnect Kit, Syringe Pump ........ 97000-62075**

Screw, pan head, Phillips, 6-32 × 3/8-in., stainless steel ........ 00415-63206
Syringe pump ........ 97000-98021

# Turbomolecular Pump

Bushing, step, rubber, 0.87-in. OD, 0.31-in. ID. .................... 00201-20050
O-ring, 0.299-in. ID, 3/32-in. thick, Viton .................... 00107-05950
O-ring, 4.100-in. ID, 3/16-in. thick, Viton .................... 00107-11100
Pump oil, turbomolecular, reservoir, felt, TPH 240 .................... 00950-01116
Rail, turbomolecular pump, mount kit .................... 97033-62200
Pump, turbomolecular, TMH 260/130, 200 L/s .................... 00108-02642
Screw, socket, 5/16-in. × 18 × 5.0-in. long, stainless steel .................... 00419-63010
Washer, flat, 5/16-in. ID, stainless steel .................... 00471-50010

# Rotary-Vane Pumps

Pump, mechanical, 640 L, Edwards 30 (2 each) .................... 00108-02655

**Interconnect Kit .................... 97044-60130**

Adapter, hose 25 mm (2 each) .................... 00108-09005
Clamp, hose, adjustable, 0.81-in. to 1.5-in., stainless steel (4 each) .................... 00108-09001
Hose, reinforced vacuum .................... 00301-24141
Union, triple forelines .................... 97000-20283
Vacuum hardware, clamp, KF20/25 .................... 00102-10020

# Vacuum System Assemblies

**Assembly, Vent Valve .................... 97000-60128**

Filter, sintered nylon .................... 00201-06050
Fitting, Swagelok, male adapter, 1/8-in. MPT × 1/4-in. .................... 00101-01740
Fitting, Swagelok, O-seal, 1/4-in. tube, 7/16-in. × 20 .................... 00101-13510
O-ring, 0.424-in. ID, 0.103-in. thick, Viton .................... 00107-05550
Ribbon dope, 1/4-in. .................... 00301-16501
Valve, 2 way, solenoid, 6 V dc, 1/32-in., stainless steel, normally open .................... 00110-10708

**Assembly, Foreline Interconnect .................... 97033-60200**

Clamp, hose, adjustable, 0.81-in. to 1.5-in., stainless steel .................... 00108-09001
Hose, adapter, 25 mm .................... 00108-09005
Hose, PVC, reinforced, 1.0-in. ID, 1.25-in. OD .................... 00301-24141
Union, duo, forelines, 90 degree .................... 97000-20294
Union, triple, forelines .................... 97000-20283
Vacuum hardware, clamp, KF 20/25, steel .................... 00102-10070

**Assembly, Helium, Inlet ........................................ 97000-60137**

Ferrule, 1/8-in. to 0.4 mm, graphite / Vespel ........................................ 00101-18115
Fitting, Swagelok, bulkhead-union, 1/8-in. × 1/8-in., brass ........................................ 00101-02101
Fitting, Swagelok, plug, 1/8-in. FPT, brass ........................................ 00101-02210
Regulator, 0-10 psi, 1/8-in., NPT, stainless steel ........................................ 00105-03010
Tubing, fused silica, 0.075 mm ID 0.67 ft. (0.2 m) *l* ........................................ 00106-10520
Tubing, Teflon, 0.125-in. OD, 0.030-in. width, FEP ........................................ 00101-50000

**Kit, Hose Adapter ........................................ 97000-62005**

Adapter, pump manifold, 1.0-in. hose to wall ........................................ 97000-20215
Convectron™ gauge ........................................ 00105-00501
O-ring, 0.862-in. ID, 0.103-in. thick, Viton ........................................ 00107-15350
Ribbon dope, 1/4-in.. ........................................ 00301-16501
Screw, pan head, Phillips, 6-32 × 1-1/2-in., stainless steel ........................................ 00425-63224

**Kit, Lid Manifold ........................................ 97000-62006**

Manifold lid ........................................ 97000-20243
O-ring, 3.6-in. ID, 0.21-in. thick, Viton ........................................ 00107-14050
Screw, pan head, Phillips, 6-32 × 3/8-in., stainless steel ........................................ 00415-63206

**Kit, Ion Gauge ........................................ 97000-62010**

Dynode shield, ........................................ 97000-20282
Ion gauge, mini, 0.75-in. OD tube ........................................ 00105-01525
O-ring, 0.737-in. ID, 3/32-in. thick, Viton ........................................ 00107-10056
Sleeve, 0.75-in. ID, O-ring compression ........................................ 97000-20211
Sleeve, threaded O-ring seal ........................................ 97000-20212

## Mechanical Assemblies

Cover, top, octapole RF voltage coil ........................................ 97000-60162

Fan, low pass filter, vent control ........................................ 97000-60156

Fan, tower ........................................ 97000-60153

## Electrical Assemblies

Assembly, Turbomolecular Pump Controller ........................................ 97000-60150

Power supply, 8 kV, 100 µA, without bracket (ESI / APCI) ........................................ 70005-98037

Transformer, 240 VA toroid ........................................ 97000-98001

**Assembly, Power Module ........................................ 97044-60050**

Circuit breaker, 15 A, double-pole, high in-rush ........................................ 00019-00522
Circuit breaker, 2 pole, 10 A, 230 V ac, unmarked rocker ........................................ 00019-00508
Connector, panel, power inlet, IEC 320/C20 ........................................ 00004-89660
Filter, line, 20 A, screw terminal ........................................ 00007-18349

Fuse, 3.15 A, 5 × 20 mm, 250 V, time lag ......................................................00006-10510
Nut, hex-KEP, 10-32, stainless steel.................................................................00461-20320
Screw, flat, Phillips, 4-40 × 3/8-in., stainless steel............................................00407-44006
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel ..................................00415-63208
Shunt, insulated, mini wrap................................................................................00004-89551
Switching power supply, 24 V (1.1 A) ............................................................00012-52104

**Assembly, Switching Power Supply .................................................................. 97000-60151**

Power supply, +36 V (11 A), -28 V (4.2 A)......................................................00012-24223
Power supply, +5 V, ±15 V, +24V, 200 W.......................................................00012-24221

**Module, Electron Multiplier / Conversion Dynode Power Supply.................. 97000-98042**

## Printed Circuit Boards (PCBs)

PCB, Analyzer Top Cover ..................................................................................... 97033-61051

PCB, Analyzer Auxiliary....................................................................................... 97000-61340
Fuse, 1.60 A, 5 × 20 mm, 250 V, quick acting, (F1 – F2) .................................00006-08610

PCB, DC Ring Filter.............................................................................................. 96000-61130

PCB, Divert / Inject Valve ..................................................................................... 97000-61390

**PCBs, Embedded Computer**
PCB, Acquisition DSP .........................................................................................97000-61260
PCB, Control DSP ...............................................................................................97000-61270
PCB, CPU ............................................................................................................97044-60250
PCB, Ethernet, SMC.............................................................................................97000-60165
PCB, Waveform DDS ..........................................................................................97000-61430

PCB, Front Panel.................................................................................................... 97000-61400

PCB, I/O Panel ...................................................................................................... 97000-61421

PCB, Low Pass Filter............................................................................................. 97000-61380

**PCB, RF Voltage Amplifier................................................................................. 96000-61090**
Fuse, 0.50 A, 5 × 20 mm, 250 V, quick acting, (F2) ........................................00006-07608
Fuse, 1.00 A, 5 × 20 mm, 250 V, quick acting, (F1) ........................................00006-07610

PCB, RF Voltage Control ..................................................................................... 96000-61100

PCB, Syringe Pump................................................................................................ 97000-61410

**PCB, System Control........................................................................................... 97044-61010**
Fuse, 0.16 A, 5 × 20 mm, 250 V, time lag (F1 – F4).........................................00006-01700
Fuse, 0.25 A, 5 × 20 mm, 250 V, time lag (F7).................................................00006-11204
Fuse, 0.40 A, 5 × 20 mm, 250 V, time lag (F8 – F9).........................................00006-05080
Fuse, 2.50 A, 5 × 20 mm, 250 V, type F (F6) ...................................................00006-11202
Fuse, 2.50 A, 5 × 20 mm, 250 V, time lag (F10)...............................................00006-09510
Fuse, 3.15 A, 5 × 20 mm, 250 V, time lag (F5).................................................00006-10510

**PCB, Vent Delay ........ 97000-61370**
Battery, 7.2 V, nickel / cadmium ........ 00301-05720

PCB, Waveform Amplifier ........ 96000-61110

## RF Control / Detection Assemblies

**Assembly, RF Tuning ........ 97000-60141**

Assembly, RF detector ........ 97000-60078
Assembly, RF plate ceramic ........ 97000-60133
Connector, coax, BNC bulkhead jack, RU-58 ........ 00004-33000
RF detector lid housing ........ 97000-20186
RF detector plate insulator ........ 96000-20048
RF detector ring shield ........ 97000-20266
Screw, pan head, Phillips, 6-32 × 3/8-in., stainless steel ........ 00415-63206
Stud, fine tuning ........ 94011-20107
Terminal lug, ring, # 6, solder ........ 00007-41500
Terminal lug, ring, 3/8-in., solder ........ 00007-39500
Tubing, Teflon, 18 gauge, 0.016-in. wall thickness ........ 00007-94330

**Kit, RF Feedthrough ........ 96000-62024**

O-ring, 1.37-in. ID, 0.103-in. thick, Viton ........ 00107-10400
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel ........ 00415-63208
RF feedthrough ........ 97000-60169

## Cables

**Kit, chassis cables ........ 97044-62050**

Cable, electron multiplier power supply – electron multiplier feedthrough ........ 96000-63008
Cord, power, 230 V ac, 15 A, North America ........ 96000-98035
Cord, power, 230 V ac, 15 A, International ........ 96000-98036
Cable, System Control PCB – ion gauge – Convectron gauge ........ 97000-63001
Cable, API stack internal – heated capillary, tube lens, skimmer ........ 97000-63002
Cable, System Control PCB – spray shield assembly – external interlock ........ 97000-63005
Cable, API front panel – APCI heater ........ 97000-63006
Cable, System Control PCB – API front panel – APCI heater ........ 97000-63007
Cable, API front panel – 8 kV API probe connector HV ........ 97000-63008
Cable, 8 kV power supply – API front panel ........ 97000-63009
Cable, Serial I/O PCB – Divert Valve Select PCB (ribbon) ........ 97000-63011
Cable, System Control PCB – I/O Panel PCB (ribbon) ........ 97000-63013
Cable, System Control PCB – RF Voltage Control PCB (ribbon) ........ 97000-63015
Cable, System Control PCB – Conversion Dynode Power Supply PCB (15 kV) – Electron Multiplier Power Supply PCB ........ 97000-63016
Cable, Electron Multiplier Power Supply PCB – electron multiplier HV connector (top cover plate) (coax) ........ 97000-63017
Cable, Analyzer PCB – Acquisition DSP PCB (embedded computer) ........ 97000-63018

Cable, System Control PCB –Analyzer Auxiliary PCB ....................................97044-63030
Cable, Analyzer Auxiliary PCB – Analyzer PCB – RF Voltage
Amplifier PCB (4 cables).............................................................................97000-63022
Cable, Vent Delay PCB – vent valve..............................................................97000-63023
Cable, power supply +36 V (11 A), -28 V (4.2 A) – RF Voltage
Amplifier PCB – Waveform Amplifier PCB – Analyzer Auxiliary PCB......97000-63024
Cable, power supply (+5 V, ±15 V, +24 V, 200 W) – ISA bus
(embedded computer motherboard) – System Control PCB – system fans....97000-63025
Cable, Power Module – power supplies (+5, +15, +24, +36) ............................97000-63026
Cable, Power Module reset button – embedded computer reset connector ........97000-63027
Cable, interconnect (power module) power supply
(+5 V, ±15 V, +24 V, 200 W) – System Control PCB..................................97000-63028
Cable, 24 V keep-alive power supply (Power Module) –
turbomolecular pump fan – Vent Delay PCB..............................................97000-63029
Harness, Power Module .....................................................................................97044-63010
Cable, interconnect (embedded computer), Control DSP
PCB – Acquisition DSP PCB (ribbon).........................................................97000-63031
Cable, interconnect (embedded computer), Control DSP
PCB – Waveform DDS PCB (ribbon).........................................................97000-63032
Cable, interconnect (embedded computer), ISA bus
(embedded computer motherboard) – CPU PCB reset (ribbon)....................97000-63033
Cable, RF Voltage Amplifier PCB – Low Pass Filter PCB (coax) ....................97000-63034
Cable, Low Pass Filter PCB – RF voltage coil connection at front box.............97000-63035
Cable, System Control PCB – Front Panel PCB (ribbon).................................97000-63036
Cable, Front Panel PCB – Serial I/O PCB .......................................................97044-63050
Cable, Power Module – internal Ethernet connector – Ethernet PCB
(embedded computer).....................................................................................97000-63040
Cable, Waveform DDS PCB (embedded computer) – Waveform
Amplifier PCB – RF Voltage Amplifier PCB – Analyzer Auxiliary PCB.....97000-63041
Cable, System Control PCB – Control DSP PCB
(embedded computer).....................................................................................97000-63042
Cable, Turbomolecular Pump Controller – Serial I/O PCB
(embedded computer) ....................................................................................97000-63043
Cable, Power Module – Turbomolecular Pump Controller...............................97000-63045
Cable, switching power supply – embedded computer fan – RF
Voltage Control PCB fan – interconnect to tower fans.................................97000-63046
Cable, RF Voltage Control PCB – RF Voltage Amplifier PCB.........................97000-63047
Cable, RS232, RJ11 – 10-pin Header ...............................................................97044-63020
Cable, System Control PCB – RF Voltage Amplifier PCB – Waveform
DDS PCB (ribbon).........................................................................................97000-63048
Cable, System Control PCB – Analyzer Auxiliary PCB (ribbon)......................97000-63049
Cable, System Control PCB – spray shield – external interconnect ..................97000-63050
Cable, Sheath / Aux gas valve – I/O Panel PCB ..............................................97000-63051

## Covers

Cover, Analyzer PCB, small....................97000-98033

Cover, Analyzer Auxiliary PCB....................97000-10088

Cover, balun, shield....................96000-98013

Cover, box, balun....................97000-98032

Cover, manifold front, interconnect....................97000-40003

Cover, RF Voltage Amplifier PCB....................97000-10028

Cover, Waveform Amplifier PCB....................97000-10029

Cover, zero box, RF voltage detector....................97000-20262

## Data System – Hardware

**Kit, Data System, Hardware....................97000-62038**

Cable, thinwire Ethernet....................00012-50969
Connector, T-Connector, thinwire Ethernet....................00012-50967
Terminator, thinwire Ethernet....................00950-00918

## Chemicals Kit

**Kit, Chemicals....................97000-62042**

Caffeine, 1 mg/mL, in methanol....................00301-12310
Reserpine, 1 gram....................00301-12901
Met-Arg-Phe-Ala (MRFA), solids....................00301-07702
Sample, Met-Arg-Phe-Ala (MRFA), solids, 10 mg each....................40061-60002

# Accessory Kit

**Accessory Kit ........................................................................................ 97044-62070**

Air duct, 1.0-in. ID, flex, blue, 15 ft. (4.5 m) *l*..............................................00301-08301
Cable, shielded, 2-twisted pair, 22 gauge, 24 ft. (7 m) *l* ..................................00302-01800
Cable, serial, DB9M-DB9F................................................................................00012-51089
Chemicals kit.......................................................................................................97000-62042
Ferrule, HPLC, 1/16-in. stainless steel, Valco (4 each) ....................................00101-18122
Ferrule, Fingertight 2, Upchurch (3 each)..........................................................00101-18196
Ferrule, Tefzel, 1/16-in., electrospray (2 each) ................................................00102-10148
Ferrule, 0.008-in. ID, KEL-F, HPLC (4 each) ...................................................00101-18114
Ferrule, 0.016-in. ID, PEEK, HPLC (4 each).....................................................00101-18120
Fitting, ferrule, 1/8-in., Tefzel (2 each)..............................................................00101-18199
Fitting, ferrule, Swagelok, back, 1/4-in. (2 each) ..............................................00101-04000
Fitting, ferrule, Swagelok, front, 1/4-in. (2 each)..............................................00101-10000
Fitting, ferrule, Swagelok, front, 1/8-in. (2 each)..............................................00101-08500
Fitting, ferrule, Swagelok, back, 1/8-in. (2 each) ..............................................00101-02500
Fitting, Fingertight 2, Upchurch (2 each)...........................................................00101-18195
Fitting, HPLC union, 0.010-in. orifice, PEEK (2 each).....................................00101-18202
Fitting, HPLC, tee, 0.020-in. orifice, PEEK (1 each) ........................................00101-18204
Fitting, Swagelok, nut, 1/4-in., brass (1 each)...................................................00101-12500
Fitting, Swagelok, nut, 1/8-in., brass (2 each)...................................................00101-15500
Fitting, tee, 1-in., barbed (1 each)......................................................................00102-10120
Fuse, 0.16 A, 5 × 20 mm, 250 V, time lag (8 each)...........................................00006-01700
Fuse, 0.25 A, 5 × 20 mm, 250 V, time lag (2 each)...........................................00006-11204
Fuse, 0.40 A, 5 × 20 mm, 250 V, time lag (4 each)...........................................00006-05080
Fuse, 0.50 A, 5 × 20 mm, 250 V, quick acting (2 each) ....................................00006-07608
Fuse, 1.00 A, 5 × 20 mm, 250 V, quick acting (2 each) ....................................00006-07610
Fuse, 2.50 A, 5 × 20 mm, 250 V, time lag (2 each)...........................................00006-09510
Fuse, 2.50 A, 5 × 20 mm, 250 V, T-F (2 each) ..................................................00006-11202
Fuse, 3.15 A, 5 × 20 mm, 250 V, time lag (4 each)...........................................00006-10510
Hose, PVC, reinforced, 1.0-in. ID, 1.25-in. OD................................................00301-24141
Manual, HPLC troubleshooting (1 each) ...........................................................00920-05914
Needle, corona discharge ....................................................................................70005-98033
Needle, ESI, D point, 26 gauge, 2-in. long (51 mm) 1 each ..............................00950-00990
Nut, flangeless, 1/16-in., electrospray (1 pack).................................................00102-10146
Nut, 1/16-in., stainless steel, Valco ...................................................................00110-16008
O-ring, .299-in. ID × .103-in. thick, Kalrez .......................................................00107-10059
Pump oil, rotary-vane vacuum pump, 1 L..........................................................00301-15101
Sample loop, 20 µL, stainless steel, Valco.......................................................00301-30000
Seal, ESI needle, 5000 series.............................................................................00950-00952
Sleeve, heated capillary .....................................................................................70005-20224
Spray cap.............................................................................................................97000-20347
Syringe, 10 µL, Rheodyne (1 each)...................................................................00301-19008
Syringe, 250 µL, Gastight®, removable needle (2 each)..................................00301-19015
Syringe, 500 µL Gastight, removable needle (1 each)......................................00301-19016
Tube, copper, 1/8-in. OD × 0.030-in. wall, refrigerant, 16.5 ft. (5 m) *l*.............00301-22701

Tube, hypodermic 26 gauge × 10-in. (254 mm) , 304S
stainless steel (1 each).........00106-20005
Tube, Teflon, 0.030-in. ID × 1/16-in. OD, 1.5 ft. (0.5 m) *l*.........00301-22915
Tubing, 0.25-in. OD × 0.062-in. wall thickness, PFA, 15 ft. (4.5 m) *l*.........00101-50100
Tubing, fused silica, 0.150 mm ID × 0.390 mm OD, 2 ft. (0.6 m) *l*.........00106-10498
Tubing, fused silica, 0.050 mm ID × 0.190 mm OD, 6 ft. ( 1.8 m) *l*.........00106-10502
Tubing, fused silica, 0.1 mm ID × 0.4 mm OD, deactivated 3 ft. (1 m).........00106-10504
Tubing, fused silica, 0.1 mm ID × 0.190 mm OD, 6 ft. (1.8 m) *l*.........00106-10499
Tubing, PVC, unreinforced, clear, 3/8-in. ID, 10 ft. (3 m) *l*.........00301-22895
Tubing, PEEK, red, 0.005-in. ID × 1/16-in. OD, 5 ft. (1.5 m) *l*.........00301-22912
Wrench, Allen / Hex 1/4-in. ball point.........00725-00022

# Recommended Spares

Battery, 7.2 V, nickel / cadmium.........00301-05720

Bushing, snap, 1.75-in. diameter, white plastic.........00201-19081

Dc ring filter box.........97000-98004

Fan gasket.........97000-20298

Fan, 100 cfm, 24 V dc.........00013-00243

Fan, kit.........97000-62021

Filter, fan.........97000-20299

Finger guard.........00007-18600

Fitting, Swagelok, bulkhead-union, 1/8-in. × 1/8-in., stainless steel.........00101-02102

Foot, bumper.........00007-18115

Fuse, 0.16 A, 5 × 20 mm, 250 V, time lag.........00006-01700

Fuse, 0.25 A, 5 × 20 mm, 250 V, time lag.........00006-11204

Fuse, 0.40 A, 5 × 20 mm, 250 V, time lag.........00006-05080

Fuse, 0.50 A, 5 × 20 mm, 250 V, quick acting.........00006-07608

Fuse, 1.00 A, 5 × 20 mm, 250 V, quick acting.........00006-07610

Fuse, 1.60 A, 5 × 20 mm, 250 V, quick acting.........00006-08610

Fuse, 2.50 A, 5 × 20 mm, 250 V, Type F.........00006-11202

Fuse, 2.50 A, 5 × 20 mm, 250 V, time lag.........00006-09510

Fuse, 3.15 A, 5 × 20 mm, 250 V, time lag.........00006-10510

Hinge, open 180 degree.........00250-08003

Nut, hex-KEP, 6-32, cadmium plated.........00460-16321

Nut, hex-KEP, 8-32, stainless steel.........00461-28320

Plug, 1.75-in. diameter, white, nylon.........00201-20500

Pump oil, turbomolecular, reservoir, felt, TPH 240.........00950-01116

Pump oil, rotary-vane vacuum pump, 1 L .......... 00301-15101
Screw, pan head, Phillips, 6-32 × 1 3/4-in., zinc plated.......... 00405-63228
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel .......... 00415-63208
Screw, pan head, Phillips, 6-32 × 1/4-in., stainless steel .......... 00415-63204
Screw, pan head, Phillips, 6-32 × 3/8-in., stainless steel .......... 00415-63206
Screw, pan head, slot, 2-56 × 1/4-in., stainless steel .......... 00414-25604
Screw, pan head, slot, 6-32 × 1/4-in., cadmium plated.......... 00404-63204
Stud, ball, 6-32 × 0.375-in. .......... 00201-12110
Switchcap, manifold cover, interconnect.......... 97000-40009
Switchcap, right door, interconnect.......... 97000-40010
Tubing, Teflon, 18 gauge, 0.016-in. wall thickness .......... 00007-94330
Valve assembly, sheath/aux gas, dual manifold.......... 00110-20014
Washer, flat, #6, stainless steel.......... 00472-00600
Washer, interlock, 5/16-in. ID, stainless steel.......... 00479-04400

# Divert / Inject Valve Accessories

Ferrule, HPLC 1/16-in. stainless steel, Valco .......... 00101-18122
Syringe adapter, 1/16-in. fill port liner / ferrule, Valco .......... 00110-16002
Syringe adapter, 1/16-in. fill port, Valco .......... 00110-16000
Valve, replacement nut, 1/16-in. HPLC, stainless steel.......... 00110-16008
Valve, replacement rotor seal, Valco.......... 00110-16006
Valve, replacement stator, Valco.......... 00110-16004
5 µL sample loop, stainless steel, Valco.......... 00110-16010
20 µL sample loop, stainless steel, Valco.......... 00301-30000

# Optional Tools

Hexdriver, 0.28-in. .......... 00025-01810
Hexdriver, 0.35-in. .......... 00025-08041
Tool pin extractor, AMP, large .......... 00725-00013
Tool pin extractor, AMP, small.......... 00725-00020
Wrench, Allen / hex drive, 1/4-in. (with handle).......... 00725-00015

# Appendix A
# Troubleshooting

Appendix A provides a flowchart and tables that can be used to troubleshoot the LCQDECA.

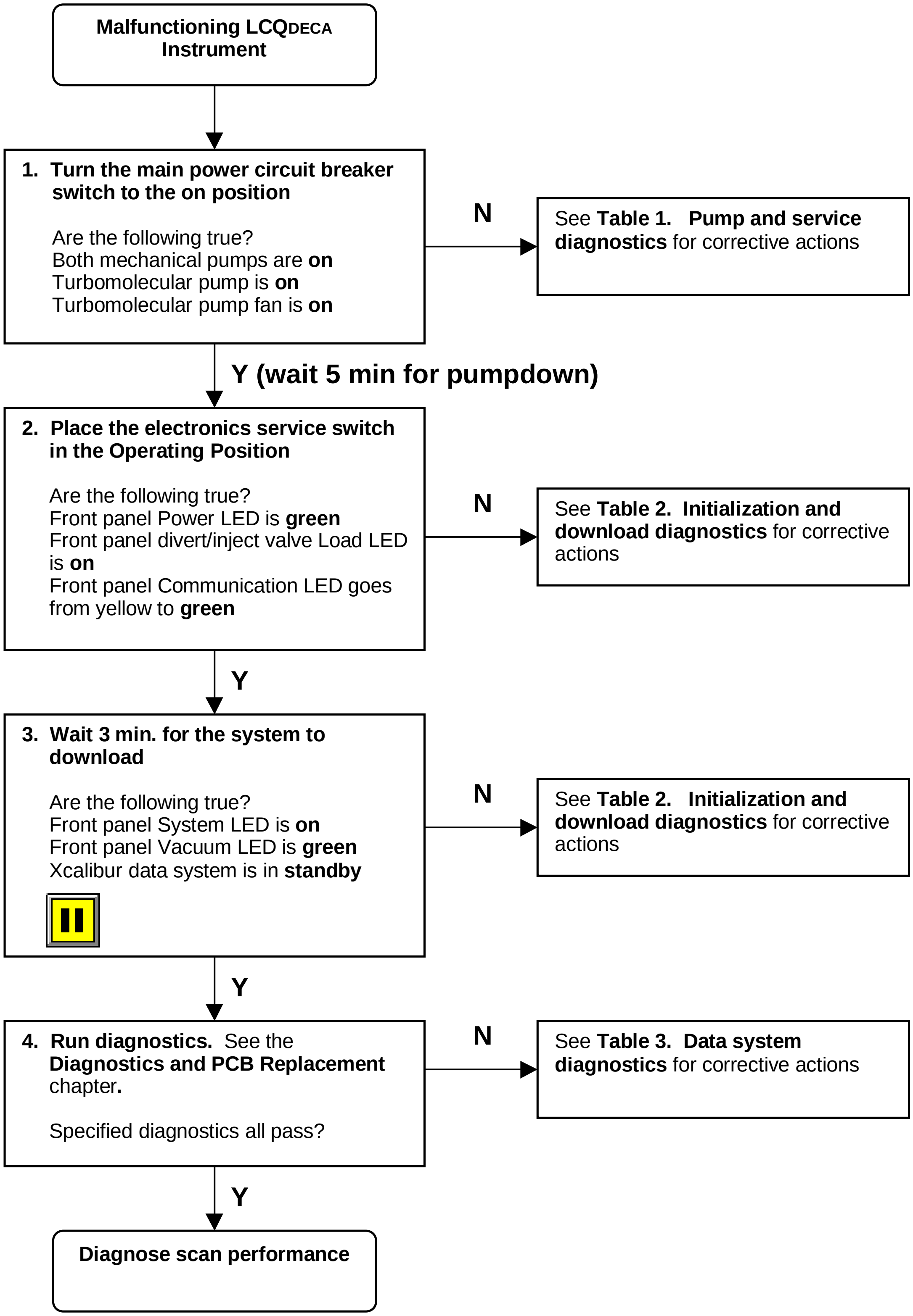



**Figure A-1. LCQDECA Power-up diagnostic flowchart**

**Table A-1. Pump and service diagnostics**

| Step | User Input or Action | Normal Conditions | Normal Indications | **Failure Corrections**<br>After a repair go back to the top of the flowchart and look for additional symptoms |
|---|---|---|---|---|
| 1 | Main Power circuit breaker switch is **on**<br><br>Electronics service switch is in **Service Position** | Mechanical pumps are **on** | Check for sound of both mechanical pumps | Check Main Power circuit breaker switch and AC power outlets |
| 2 | | Pump cooling fan is **on** | Check for sound of fans<br><br>Check for cooling air through the rear dust filter and I/O panel side vent | Check fan cables and 24 V power supply |
| 3 | | Turbomolecular pump is **on** | Open front panel doors and listen for the spin-up sound of the turbomolecular pump | Check turbomolecular pump, pump controller module and associated cables |
| 4 | | Pump-down occurs with no audible vacuum leaks | Check for vacuum leak sounds<br><br>Vent Delay PCB LED (remove top cover) is **on** (vent delay is 30 to 40 s) | Locate the leak source<br><br>Check the Vent Delay PCB LED and 24 V power supply |
| **To extend the life of the ion gauge, plug the heated capillary with a septum and allow the system to pump down for 5 min or longer before turning on the electronic service switch** | | | | |

**Table A-2. Initialization and download diagnostics**

| Time (min:s) | User Input or Action | Normal Conditions | Normal Indications | Failure Corrections<br>After a repair go back to the top of the flowchart and look for additional symptoms |
|---|---|---|---|---|
| **To extend the life of the ion gauge, plug the heated capillary with a septum and allow the system to pump down for 5 min or longer before turning on the electronic service switch** | | | | |
| 0:00 | Place electronics service switch in **Operating Position** or press **Reset** button | +5 V dc power supply powers embedded computer | Power LED (front LED panel) stays **green**<br><br>One divert/inject LED is **on**<br><br>System Control PCB RESET LED (remove right side cover) is **on** | Check +5 V dc power supply and associated cables, check AC power from electronics service switch to +5V dc power supply<br><br>Check Divert/Inject Valve LED PCB, I/O Panel PCB and associated cables<br>Check power cables to System Control PCB |
| 0:10 | | Embedded computer checks DRAM then the CPU PCB BIOS starts | Same as above | See above |
| 0:21 | | CPU PCB runs PSOS Boot Loader from Flash drive | Same as above | See above |
| 0:23 | | PSOS Boot Loader locates Ethernet card at IRQ10, then calls host data system | Communication LED (front LED panel) is **yellow**<br><br>Ethernet PCB T/R LED (Ethernet bracket on embedded computer, open front door) **blinks**. See Figure 5-4 | Check ribbon cable from System Control PCB to front LED panel<br><br>Replace Ethernet PCB if T/R LED does not blink |
| 0:25 | | Host data system acknowledges PSOS Boot Loader and downloads X86 application files | Communication LED (Front LED panel) changes to **green** | If Communication LED is yellow, then check the following: data system computer hard drive for corruption and correct Ethernet address, thinwire Ethernet cable to data system computer, Ethernet terminators are secure, configuration jumper is set to pin 3 on Ethernet PCB<br><br>If necessary replace Ethernet PCB and update Ethernet address in data system computer |

**Table A-2. Initialization and download diagnostics (continued)**

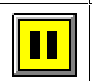
| | | | | |
|---|---|---|---|---|
| 0:30 | | X86 EXECTask application resets Control DSP PCB | Control DSP PCB (embedded computer) RESET LED is **red**. See Figure 5-4<br><br>Waveform DDS PCB (embedded computer) RESET LED is **green**<br><br>System Control PCB (remove right side cover) RESET LED is **off** | Check cables in Embedded Computer, check Control DSP PCB<br><br>Check Waveform DDS PCB and associated cables<br><br>Check cable from Waveform DDS PCB to System Control PCB |
| 0:34 | | X86 EXECTask application resets Acquisition DSP PCB | Acquisition DSP PCB (embedded computer) RESET LED is **red**. See Figure 5-4 | Check cables in Embedded Computer, check Acquisition DSP PCB |
| 0:40 | | Data system down-loads ICL files to LCQDECA and recompiles | Data system computer downloads files. Data system computer screen shows instrument initialization | Check data system computer hard drive for corruption |
| 2:10 | | LCQDECA begins initialization | Vacuum LED (front LED panel) is **green**<br><br>System Control PCB high voltage relay **clicks** | Check ribbon cable from System Control PCB to front LED panel, check data system computer for error messages<br><br>If necessary replace Control DSP PCB |
| 2:22 | | LCQDECA in standby mode and ion gauge is **on**  | System LED (front LED panel) is **yellow**<br><br>Data system computer screen displays **Instrument in Standby** | Check ribbon cable from System Control PCB to front LED panel, check cable from Control DSP PCB to System Control PCB |

**Table A-3. Data system diagnostics**

| Step | User Input or Action | Normal Conditions | Normal Indications | Failure Corrections<br>After a repair go back to the top of the flowchart and look for additional symptoms |
|---|---|---|---|---|
| 1 | Select **scan mode** in Tune Plus<br>Select **Graph View**<br>Select **Status View** | Instrument is in **scan mode** | All front LED panel LEDs are **green** except Syringe LED which is off and Scan LED which is **blue**<br>Scan LED (front LED panel) **blinks** to Total Microscans spin box value (in Define Scan dialog box), Control DSP PCB LED **blinks**, Acquisition DSP PCB LED **blinks**, Waveform DDS PCB LED **blinks**<br>High Voltage Power Supply ON EM LED (visible with left front panel open) **blinks** to Total Microscans spin box value<br>One High Voltage Power Supply NEG/POS DYNODE LED (visible with left front panel open) is **on**. In negative ion mode the POS DYNODE LED is **on**, in positive ion mode the NEG DYNODE LED is **on** | Investigate each LED failure, check associated cables, modules, and PCBs |
| 2 | Choose **Diagnostics \| Diagnostics** in Tune Plus<br>Select **All** tab<br>Check ( ☑ ) Everything<br>Select **Start** | Diagnostic test performed (5 min)<br>See **Table 5-2** for diagnostics tested | Diagnostics dialog box reports all results as **Pass** | Select to the appropriate diagnostics tab and repeat the diagnostic test<br>See **Table 4. Diagnostics details** for signal paths and potential repair locations |
| 3 | Choose **Diagnostics \| Diagnostics** in Tune Plus<br>Select **RF(2)** tab<br>Select **Start** | Diagnostic test performed (30 s) | Diagnostics dialog box reports all results as **Pass** | Investigate each readback failure, check associated fuses, cables & modules<br>See **Table 4. Diagnostics details** for signal paths and potential repair locations |

**Table A-3. Data system diagnostics (continued)**

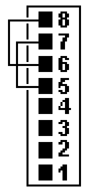
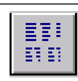
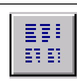
| | | | | |
|---|---|---|---|---|
| 4 | Insert contact closure test plug into **Peripheral Control** terminal. See next column for test plug wiring<br>Choose **Diagnostics \| Diagnostics** in Tune Plus<br>Select **Graphs** tab<br>Select **Contact closure test** in Test Type list box<br>Select **Start**<br>Skip this step if Peripheral Control terminal (I/O Panel) is not used | Diagnostics test performed (10 s)<br>wiring for contact closure test plug   | Diagnostics dialog box reports all results as **Pass** | Check I/O panel and cables<br>Check DIO circuit on System Control PCB |
| 5 | Select **Status View** in Tune Plus <br>Scroll to **TURBO PUMP** | Check for normal range values:<br>Speed (rpm)<br>Power (watt)<br>Temperature (°C) | 60000 +/- 1%<br>6 to 50 watts<br>30 °C to 45 °C | Investigate each readback failure, check associated cables and modules<br>Investigate the following signal path and potential repair locations: Turbo pump, turbo controller, serial cable, Embedded CPU-serial-port |
| 6 | Select **Status View** in Tune Plus <br>Scroll to **ANALOG IN**<br>Skip this step if Analog In bus terminal (I/O Panel) is not used | Check for normal voltage | 0 to 1.0 V | Investigate each readback failure, check associated fuses, cables and modules<br>See **Table 4. Diagnostics details** for signal paths and potential repair locations |

**Table A-3. Data system diagnostics (continued)**

| | | | | |
|---|---|---|---|---|
| 7 | Select **Status View** in Tune Plus<br><br>Scroll to **DIGITAL INPUTS STATUS**<br><br>Press the Divert/Inject Valve switch (front panel) | Divert/Inject LEDs toggle between Load and Inject | Divert/Inject LED matches DIGITAL INPUTS STATUS reading | Investigate the following signal path and potential repair locations: Diveret/Inject PCB, valve, cable, I/O PCB |
| 8 | Remove septum from heated capillary<br><br>Load syringe pump<br><br>Select **Status View** in Tune Plus<br><br>Scroll to **SYRINGE PUMP STATUS**<br><br>Start syringe pump in Tune Plus | Syringe pump is **on**<br><br>Check for normal range values:<br><br>Flow Rate (µL/min)<br>Infused Volume (µL)<br>Syringe Diameter (mm) | Syringe LED (front panel) is **green**<br><br>Feel syringe pump pulsate | Investigate each readback failure, check associated fuses, cables and modules<br><br>Investigate the following signal paths and potential repair locations:<br><br>Syringe Pump, cables, I/O PCB<br><br>Syringe Control PCB, System Control PCB |

**Table A-4. Diagnostic details**

| Test Type in Diagnostics: Static/Both Static and Dynamic | Readback Device Number | Instrument Status | Device Name | Signal/Potential Repair Path |
|---|---|---|---|---|
| static | 22 | SOURCE | Discharge Voltage (kV) | APCI probe, cables, 8kV PS, cable, Sys Ctrl PCB |
| static | 21 | SOURCE | Discharge Current (µA) | APCI probe, cables, 8kV PS, cable, Sys Ctrl PCB |
| static | 29 | SOURCE | APCI Vaporizer Temp | APCI probe-vaporizer heater, cables, Sys Ctrl PCB |
| static | 22 | SOURCE | Spray Voltage (kV) | ESI probe, cables, 8kV PS, Sys Ctrl PCB |
| static | 21 | SOURCE | Spray Current (µA) | ESI probe, cables, 8kV PS, Sys Ctrl PCB |
| both | 19 | SOURCE | Sheath Gas Flow Rate | Flow valve assy, cable, I/O PCB, cable, Sys Ctrl PCB |
| both | 20 | SOURCE | Aux Gas Flow Rate | Flow valve assy, cable, I/O PCB, cable, Sys Ctrl PCB |
| both | 23 | SOURCE | Capillary Voltage | Capillary assy, cable, Sys Ctrl PCB |
| static | 28 | SOURCE | Capillary Temp | Capillary heater assy, cable, Sys Ctrl PCB |
| static | 09 | VACUUM | Ion Gauge (10E-5 Torr) | Ion Gauge, cable, Sys Ctrl PCB |
| static | 11 | VACUUM | Convectron gauge (Torr) | Convectron Gauge, cable, Sys Ctrl PCB |
| both | 30 | ION OPTICS | Octapole 1 Offset (V) | Octapole 1, Top Cover PCB, cable, Sys Ctrl PCB |
| both | 01 | ION OPTICS | Octapole 2 Offset (V) | Octapole 2, Top Cover PCB, cable, Sys Ctrl PCB |
| both | 07 | ION OPTICS | Oct Lens Voltage (V) | Octapole Lens, Top Cover PCB, cable, Sys Ctrl PCB |
| both | 04 | ION OPTICS | Trap DC Offset | Sys Ctrl PCB, cable, Top Cover PCB |
| static | 03 | ION OPTICS | Analyzer Temp (°C) | AD592 on Top PCB, cable, Sys Ctrl PCB |
| both | 10 | MAIN RF | Main RF DAC (steps) | RF Amp PCB, cable, Sys Ctrl PCB |
| static | 13 | MAIN RF | Main RF Detected (V) | RF det. PCB, cable, RF Amp PCB |
| static | 33 | MAIN RF | RF Detected Temp (°C) | AD592 on Det PCB, cable, Sys Ctrl PCB |
| static | 12 | MAIN RF | Main RF Modulation (V) | RF det. PCB, cable, RF Amp PCB |
| static | 08 | MAIN RF | Main RF Amp (Vpp) | RF Amp PCB, cable, Sys Ctrl PCB |
| static | 34 | MAIN RF | RF Generator Temp (°C) | AD592 on Gen PCB, cable, Sys Ctrl PCB |
| static | 46 | ION DETECT | Dynode Voltage (V) | EM/Dyn PS, cable, EM supply, cable, Sys Ctrl PCB |
| both | 41 | ION DETECT | Multiplier Voltage (V) | Electron Mult, cable, EM supply, cable, Sys Ctrl PCB |
| static | 18 | SUPPLIES | +5V Supply Voltage (V) | PS2 supply, Harness, Sys Ctrl PCB |
| static | 16 | SUPPLIES | -15V Supply Voltage (V) | PS2 supply, Harness, Sys Ctrl PCB |
| static | 15 | SUPPLIES | +15V Supply Voltage (V) | PS2 supply, Harness, Sys Ctrl PCB |
| static | 36 | SUPPLIES | +24V Supply Voltage (V) | PS2 supply, Harness, Sys Ctrl PCB |
| static | 32 | SUPPLIES | -28V Supply Voltage (V) | PS1, Harness, RF PCB, cable, Sys Ctrl PCB |
| static | 48 | SUPPLIES | +28V Supply Voltage (V) | PS1, Harness, RF PCB, cable, Sys Ctrl PCB |
| static | 26 | SUPPLIES | +35V Supply Voltage (V) | From toroidal transformer |
| static | 31 | SUPPLIES | +36V Supply Voltage (V) | PS1, Harness, RF PCB, cable, Sys Ctrl PCB |
| static | 38 | SUPPLIES | -150V Supply Voltage | Xfrmr or Linear Supply, Harness, Sys Ctrl PCB |

**Table A-4. Diagnostic details (continued)**

| | | | | |
|---|---|---|---|---|
| static | 24 | SUPPLIES | +150V Supply Voltage | Xfrmr or Linear Supply, Harness, Sys Ctrl PCB |
| static | 42 | SUPPLIES | -205V Supply Voltage | Xfrmr or Linear Supply, Harness, Sys Ctrl PCB |
| static | 40 | SUPPLIES | +205V Supply Voltage | Xfrmr or Linear Supply, Harness, Sys Ctrl PCB |
| static | 35 | SUPPLIES | Ambient Temp (°C) | AD592 on Sys Ctrl PCB |
| both | 17 | not listed | Tubegate (V) | Tubegate, Top Cover PCB, cable, Sys Ctrl PCB |
| static | 14 | not listed | Entrance Lens (V) | Entrance Lens, Top Cover PCB, cable, Sys Ctrl PCB |
| static | 05 | not listed | Multiplier DAC | Electron Mult, cable, EM supply, cable, Sys Ctrl PCB |

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